EXTERNAL TANK AEROTHERMAL DESIGN CRITERIA VERIFICATION

VOLUME II

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Prepared by:

William K. Crain
Cynthia Frost
John Warmbrod

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National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

FOREWORD

This final report documents the ET thermal environment generation work performed under the ET Aerothermal Design Criteria Verification study (NAS8-36946). The work was performed for the Thermal Environments Branch (ED-33) of the George C. Marshall Space Flight Center (MSFC).

During the course of the work, significant results and progress were documented in the progress reports submitted each month. The purpose of this report is to summarize the thermal environment generation methodology and to present a comparison with the Rockwell IVBC-3 environments. The report is presented in two volumes. Volume I contains the methodology and environment summaries. Volume II contains the plotted timewise environments comparing the REMTECH results to the Rockwell IVBC-3 results.

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1. MAXIMUM DESIGN HEATING RATE AND LOAD SUMMARY FOR ET ACREAGE BODY POINT LOCATIONS

2. AEROHEATING AND PLUME CONVECTION MAX HEATING RATE SUMMARY FOR BODY POINT LOCATIONS $X_T \geq 1872$

TABLE 1 MAXIMUM DESIGN HEATING RATE AND LOAD SUMMARY

a) Design Environments for the Nose Spike and 40° Cone Acreage

BODY POINT	COORDINATES		LOCATION	MAX HEATING RATES (BTU/ft²sec)		HEAT LOAD (BTU/ft²)	
	X_T (in)	θ_T (deg)		RI	REMTECH	RI	REMTECH
7000	—	—	Stag Pt of 1 Ft R. Sphere	5.68	5.75	715.6	920.8
60133	327.66	0.0	30° Conical Nose	14.98	14.98	1840.3	1698.0
60101	328.00	0.0	Tip	11.31	10.93	1593.4	1390.0
60122	328.00	180.0		10.75	10.53	1349.1	1205.0
70300	329.00	0.0		10.21	9.77	1329.2	1090.0
70350	329.00	180.0		9.64	8.99	1147.4	962.3
70375	329.00	270.0		10.87	10.63	1380.5	1158.0
70400	335.00	0.0	10° Nose Cone	4.03	3.77	498.8	439.6
70450	335.00	180.0		3.58	3.40	414.9	370.5
70475	335.00	270.0		4.73	4.26	576.9	503.0
60130	338.00	0.0		3.83	3.57	467.1	411.2
70500	342.24	0.0	40° Cone	15.25	22.07	1434.4	1568.0
70550	342.24	180.0		12.81	21.64	1122.1	1518.0
70575	342.24	270.0		13.50	22.17	1297.6	1603.0
70600	345.50	0.0		18.38	20.48	1593.5	1405.0
70650	345.50	180.0		15.45	20.08	1250.1	1370.0
70675	345.50	270.0		16.28	20.57	1435.6	1429.0
60111	349.00	14.0		22.01	19.41	1574.2	1305.0
70700	354.50	0.0		23.23	18.33	1863.2	1207.0
70750	354.50	180.0		19.52	17.97	1436.5	1184.0
70775	354.50	270.0		20.57	18.41	1643.1	1224.0
60112	357.00	8.0		18.61	17.96	1365.0	1176.0
70800	364.50	0.0		19.02	17.12	1542.7	1108.0
70850	364.50	180.0		15.98	16.78	1217.8	1086.0
70875	364.50	270.0		16.85	17.20	1379.4	1123.0

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1 CONTINUED
b) DESIGN ENVIRONMENTS FOR THE LO_2 TANK ACREAGE

BODY POINT	COORDINATES		LOCATION	MAX HEATING RATES (BTU/ft^2sec)		HEAT LOAD (BTU/ft^2)	
	X_T (in)	θ_T (deg)		RI	REMTECH	RI	REMTECH
70900	375.10	0.0	LO_2 Tank Acreage	8.97	9.00	817.3	846.2
70950	375.10	180.0		8.89	8.76	825.5	839.5
70956	375.10	202.5		8.83	8.78	816.9	842.1
70963	375.10	225.0		8.96	8.83	845.6	845.4
70969	375.10	247.5		8.99	8.86	849.1	848.6
70975	375.10	270.0		9.00	8.88	846.8	850.3
70981	375.10	292.5		8.87	8.88	808.0	851.3
70988	375.10	315.0		9.01	8.87	829.8	850.1
70994	375.10	337.5		8.93	8.84	816.9	847.8
60400	402.50	357.4		9.23	7.83	750.0	755.0
60405	402.50	16.9		11.56	8.90	875.0	833.8
60407	402.50	24.3		14.34	9.42	1016.1	893.8
60409	402.50	31.5		12.21	10.69	909.2	983.1
60411	402.50	38.7		9.31	9.02	753.0	850.5
60413	402.50	46.1		9.30	7.87	764.6	744.5
60418	402.50	65.6		10.55	7.50	760.3	713.6
60500	409.90	0.1		8.41	8.17	706.2	755.2
60507	409.90	24.9		10.91	8.55	819.7	811.5
60509	409.90	31.5		7.62	7.37	648.6	706.6
60510	409.90	38.1		7.45	7.33	653.8	701.8
60517	409.90	62.9		9.62	7.22	734.2	686.9
71000	421.30	0.0		6.60	7.13	594.5	687.0
71050	421.30	180.0		6.76	6.83	598.0	647.9
71056	421.30	202.5		6.78	7.03	597.7	668.3
71063	421.30	225.0		6.89	7.36	604.4	693.4

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1 CONTINUED
b) DESIGN ENVIRONMENTS FOR THE LO_2 TANK ACREAGE

BODY POINT	COORDINATES		LOCATION	MAX HEATING RATES (BTU/ft^2sec)		HEAT LOAD (BTU/ft^2)	
	X_T (in)	θ_T (deg)		RI	REMTECH	RI	REMTECH
71069	421.30	247.5	LO_2 Tank Acreage	7.88	7.61	681.2	719.4
71075	421.30	270.0		7.93	7.74	683.4	734.0
71081	421.30	292.5		6.95	7.79	606.7	743.1
71088	421.30	315.0		6.80	7.69	599.9	735.2
71094	421.30	337.5		6.69	7.46	595.0	716.1
60601	422.30	3.2		7.54	7.09	648.8	682.8
60607	422.30	25.8		8.96	8.27	699.0	736.7
60609	422.30	31.5		7.00	8.01	614.7	723.3
60610	422.30	37.2		8.06	6.91	670.3	674.1
60617	422.30	59.8		8.19	6.80	665.2	646.9
60701	432.10	5.0		7.35	6.77	628.5	649.3
60707	432.10	23.7		12.27	11.98	940.0	981.9
60709	432.10	31.5		12.76	10.64	940.1	878.9
60711	432.10	39.4		10.78	10.05	821.6	822.9
60716	432.10	58.0		8.00	6.48	626.2	617.4
60802	437.60	5.9		7.22	8.06	615.4	718.5
60806	437.60	21.5		9.99	10.06	747.7	859.1
60807	437.60	26.5		12.32	12.22	937.5	995.1
60809	437.60	31.5		12.19	12.22	931.1	992.8
60810	437.60	36.5		9.95	9.04	762.0	782.0
60816	437.60	57.1		8.86	8.81	706.9	742.9
71100	453.60	0.0		5.95	6.17	532.9	599.1
71150	453.60	180.0		6.30	5.85	539.8	557.4
71175	467.40	270.0		6.13	6.80	557.2	645.6
71200	467.40	0.0		5.69	5.80	486.5	566.6

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1 CONTINUED
b) DESIGN ENVIRONMENTS FOR THE LO_2 TANK ACREAGE

BODY POINT	COORDINATES		LOCATION	MAX HEATING RATES (BTU/ft^2sec)		HEAT LOAD (BTU/ft^2)	
	X_T (in)	θ_T (deg)		RI	REMTECH	RI	REMTECH
71250	467.40	180.0	LO_2 Tank Acreage	6.00	5.48	521.8	524.3
71263	467.40	225.0		5.63	6.03	512.3	570.4
71275	467.40	270.0		5.91	6.44	514.4	612.6
71288	467.40	315.0		5.89	6.38	509.0	615.8
60907	474.20	23.7		8.76	7.90	617.5	688.1
60909	474.20	31.5		10.59	10.15	755.9	839.1
60911	474.20	39.3		9.08	8.92	661.1	729.2
60915	474.20	53.5		6.23	8.77	511.3	705.1
61009	512.10	31.5		8.86	7.43	641.5	659.4
61109	512.60	31.5		6.68	7.40	493.5	657.8
71300	513.60	0.0		4.97	4.70	410.4	470.5
71350	513.60	180.0		4.49	4.39	399.3	428.1
71356	513.60	202.5		4.02	4.58	366.8	447.6
71363	513.60	225.0		4.03	4.92	362.0	472.0
71369	513.60	247.5		4.13	5.18	358.2	497.9
71375	513.60	270.0		4.95	5.33	440.7	513.0
71381	513.60	292.5		4.24	5.38	361.9	523.7
71388	513.60	315.0		4.27	5.28	396.6	517.6
71394	513.60	337.5		4.35	5.04	376.9	499.4
61111	551.30	37.3		7.39	4.94	518.8	461.3
61114	551.30	49.0		3.75	3.82	320.9	378.9
61209	591.40	31.5		5.27	3.22	409.7	338.5
71400	606.00	0.0		3.22	2.90	280.8	316.1
71450	606.00	180.0		3.38	2.65	265.7	279.9
71456	606.00	202.5		2.86	2.80	252.0	295.2

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1 CONTINUED
b) DESIGN ENVIRONMENTS FOR THE LO_2 TANK ACREAGE

BODY POINT	COORDINATES		LOCATION	MAX HEATING RATES (BTU/ft²sec)		HEAT LOAD (BTU/ft²)	
	X_T (in)	θ_T (deg)		RI	REMTECH	RI	REMTECH
71463	606.00	225.0	LO_2 Tank Acreage	2.83	3.08	246.6	313.9
71469	606.00	247.5		2.89	3.31	241.9	334.4
71475	606.00	270.0		3.71	3.44	311.8	346.8
71481	606.00	292.5		3.01	3.47	248.7	356.5
71488	606.00	315.0		3.05	3.38	258.2	352.8
71494	606.00	337.5		3.15	3.18	266.6	338.9
61309	632.30	31.5		4.34	3.13	332.4	326.2
61311	632.30	36.4		4.40	2.45	338.3	264.9
61313	632.30	46.3		2.83	3.93	236.3	387.8
61409	673.90	31.5		2.95	3.08	239.7	306.0
71500	698.00	0.0		2.16	1.97	208.7	215.5
71550	698.00	180.0		2.40	1.59	180.4	186.9
71556	698.00	202.5		1.91	1.70	170.6	197.7
71563	698.00	225.0		1.89	1.91	167.8	210.4
71569	698.00	247.5		1.89	2.07	165.1	225.0
71575	698.00	270.0		2.47	2.16	210.8	234.5
71581	698.00	292.5		1.97	2.19	168.0	242.6
71588	698.00	315.0		2.03	2.12	175.3	241.0
71594	698.00	337.5		2.10	2.03	183.0	231.6
61509	715.80	31.5		2.51	2.88	215.6	301.6
71600	751.50	0.0		1.76	1.74	160.0	182.6
71650	751.50	180.0		1.66	1.55	148.5	164.2
71675	751.50	270.0		1.97	1.79	172.6	198.3
61609	759.20	31.5		2.10	2.28	186.1	241.8
61610	759.20	33.8		3.52	2.28	263.7	235.1

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1 CONTINUED
b) DESIGN ENVIRONMENTS FOR THE LO_2 TANK ACREAGE

BODY POINT	COORDINATES		LOCATION	MAX HEATING RATE (BTU/ft²sec)		HEAT LOAD (BTU/ft²)	
	X_T (in)	θ_T (deg)		RI	REMTECH	RI	REMTECH
61611	759.20	36.0	LO_2 Tank Acreage	2.02	1.88	181.4	212.8
61613	759.20	45.1		1.65	1.76	147.8	202.2
61709	762.20	31.5		2.03	1.55	150.6	187.2
61809	773.70	31.5		2.25	2.59	169.6	260.1
61909	786.20	31.5		2.36	2.14	191.7	225.1
62009	793.10	31.5		2.88	2.43	216.5	258.9
71700	796.50	0.0		2.10	1.45	160.7	154.0
71750	796.50	180.0		2.21	1.29	164.1	138.5
71756	796.50	202.5		2.21	1.29	162.8	145.3
71763	796.50	225.0		2.21	1.44	161.6	162.2
71769	796.50	247.5		2.21	1.44	160.2	162.2
71775	796.50	270.0		2.58	1.50	192.4	167.5
71781	796.50	292.5		1.92	1.51	139.3	171.6
71788	796.50	315.0		1.92	1.47	144.7	169.8
71794	796.50	337.5		2.05	1.47	153.3	163.8
62109	827.10	31.5		2.86	2.43	215.6	259.1
71800	841.50	0.0		2.15	1.43	168.7	151.1
71850	841.50	180.0		2.18	1.27	161.5	135.7
71875	841.50	270.0		2.56	1.48	191.7	164.1

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1 CONTINUED
c) DESIGN ENVIRONMENTS FOR THE INTERTANK ACREAGE

BODY PT	COORDINATES		LOCATION	MAX HEATING RATE (Btu/ft²-sec)			HEAT LOAD (Btu/ft²)		
	X_T (in)	θ_T (deg)		RI	REMTECH		RI	REMTECH	
				w/o	w/o	w/	w/o	w/o	w/
7300	884.85	0.0	Intertank Acreage	1.86	1.45	1.53	137.1	153.6	167.9
7309	884.85	180.0		1.95	1.31	1.44	130.7	140.9	153.8
7307	884.85	225.0		1.58	1.46	1.69	107.8	156.1	170.9
7305	884.85	270.0		9.45	5.92	7.88	465.3	374.9	467.7
7304	884.85	292.5		2.00	2.54	3.25	142.9	205.9	250.2
7302	884.85	315.0		2.00	2.47	2.92	147.6	207.1	234.6
7301	884.85	337.5		1.81	1.47	1.71	136.6	161.5	180.7
7306	884.86	247.5		1.61	1.98	2.53	113.9	185.3	219.4
6410	890.00	141.3		2.51	1.63	1.98	201.6	175.5	204.6
6413	900.00	142.6		2.19	1.63	1.97	175.2	175.5	192.4
6394	905.00	31.5		1.33	1.38	1.43	119.9	154.6	167.2
7320	929.14	0.0		1.69	1.44	1.52	131.1	151.5	166.3
7329	929.14	180.0		2.08	1.30	1.39	124.4	142.5	156.7
7325	929.14	270.0		9.89	7.10	9.20	530.2	424.9	532.0
7324	929.14	292.5		4.54	4.74	6.07	242.0	309.7	381.1
7355	961.22	270.0		16.54	16.18	21.80	809.9	895.0	1134.5
1002	965.22	270.0		20.32	16.18	21.80	953.6	895.0	1134.5
1007	970.22	270.5		20.01	16.19	21.81	887.4	895.4	1135.2
1009	970.22	271.0		19.72	16.19	21.82	876.9	895.9	1135.8
1005	970.22	270.0		20.29	16.18	21.80	889.4	895.0	1134.5
1011	971.22	271.6		19.36	16.20	21.83	856.5	896.5	1136.5
7350	973.43	0.0		1.72	1.42	1.58	133.3	148.7	165.1

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1 CONTINUED
c) DESIGN ENVIRONMENTS FOR THE INTERTANK ACREAGE

BODY PT	COORDINATES		LOCATION	MAX HEATING RATE (Btu/ft^2-sec)			HEAT LOAD (Btu/ft^2)		
	X_T (in)	θ_T (deg)		RI	REMTECH		RI	REMTECH	
				w/o	w/o	w/	w/o	w/o	w/
7359	973.43	180.0	Intertank Acreage	2.06	1.28	1.40	123.4	136.9	149.1
7354	973.43	292.5		5.90	4.42	5.88	321.7	312.9	386.4
7352	973.43	315.0		5.24	3.15	4.11	316.1	252.7	307.8
6301	983.46	23.5		5.24	3.64	4.75	316.1	364.4	428.6
1012	991.07	270.0		11.81	6.71	9.09	512.2	413.3	519.0
7365	994.40	270.0		11.76	6.71	9.09	510.3	413.3	519.0
7360	1006.65	0.0		1.89	1.41	1.57	139.8	147.4	163.8
6368	1006.65	15.0		2.32	1.96	2.56	155.4	195.1	233.5
6369	1006.65	19.0		3.41	1.95	2.54	193.0	199.5	237.4
6367	1006.65	29.0		2.83	1.86	2.43	170.0	181.1	214.6
7369	1006.65	180.0		2.05	1.27	2.54	122.0	135.9	237.4
7364	1006.65	292.5		2.61	3.19	4.17	170.9	252.0	307.0
1746	1021.70	13.5		3.22	1.84	2.41	193.2	191.3	225.8
1738	1021.70	29.3		2.78	1.97	2.61	173.4	191.1	228.3
7387	1025.80	225.0		2.62	2.20	2.84	169.0	198.1	237.3
7386	1025.80	247.5		2.10	2.00	2.66	156.6	191.4	229.1
6331	1026.00	16.5		3.89	1.95	2.55	253.6	203.2	241.2
7380	1038.03	0.0		2.39	1.67	1.93	158.7	170.9	189.2
7385	1038.03	270.0		1.31	1.51	1.99	123.4	167.2	197.9
7381	1038.03	337.5		2.63	1.94	2.51	175.2	186.5	222.1
7400	1069.40	0.0		2.85	2.04	2.61	189.3	186.4	222.9
6408	1069.40	15.0		3.97	2.16	2.82	251.0	211.5	252.7

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1 CONTINUED
c) DESIGN ENVIRONMENTS FOR THE INTERTANK ACREAGE

BODY PT	COORDINATES		LOCATION	MAX HEATING RATE (Btu/ft²-sec)			HEAT LOAD (Btu/ft²)		
	X_T (in)	θ_T (deg)		RI	REMTECH		RI	REMTECH	
				w/o	w/o	w/	w/o	w/o	w/
6409	1069.40	19.0	Intertank Acreage	3.89	2.15	2.80	258.9	210.1	250.9
6407	1069.40	29.0		3.39	2.19	2.80	208.0	192.0	229.2
7409	1069.40	180.0		2.10	1.37	1.72	124.2	141.9	164.9
7406	1069.40	247.5		1.49	1.47	1.88	128.3	159.9	188.2
7405	1069.40	270.0		1.31	1.50	1.92	123.6	159.4	187.5
7404	1069.40	292.5		1.82	1.70	2.19	147.8	177.3	210.4
7401	1069.40	337.5		2.94	2.39	2.84	200.4	205.3	233.8
6395	1074.40	36.0		4.42	2.60	3.39	248.7	210.1	252.7
56282	1080.05	32.5		5.01	2.17	2.77	274.0	189.2	225.9
7420	1102.62	0.0		6.78	4.14	4.72	417.4	311.1	337.4
6429	1102.62	19.0		4.72	3.45	4.51	321.8	262.2	322.3
6427	1102.62	29.0		2.09	2.69	3.44	197.7	204.7	245.5
6424	1102.62	37.7		4.72	2.02	2.58	266.8	181.3	216.2
7429	1102.62	180.0		2.25	1.26	1.68	129.9	142.4	166.6
7427	1102.62	225.0		2.48	2.19	2.81	162.7	195.1	233.9
7426	1102.62	247.5		1.52	1.46	1.87	129.3	158.8	187.0
7425	1102.62	270.0		1.30	1.49	1.91	123.7	158.3	186.3
7424	1102.62	292.5		1.64	1.70	2.19	137.5	176.2	209.1
7422	1102.62	315.0		4.42	2.79	3.57	231.8	213.0	255.9
7421	1102.62	337.5		3.77	2.91	3.75	245.2	236.4	288.1
6286	1111.20	23.5		5.09	3.13	4.08	313.1	274.6	337.8
1100	1111.85	343.0		4.64	3.98	5.31	321.6	333.3	411.6
1107	1111.85	348.0		3.76	3.51	4.66	286.9	308.9	379.9

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1 CONTINUED
c) DESIGN ENVIRONMENTS FOR THE INTERTANK ACREAGE

BODY PT	COORDINATES		LOCATION	MAX HEATING RATE (Btu/ft^2-sec)			HEAT LOAD (Btu/ft^2)		
	X_T (in)	θ_T (deg)		RI	REMTECH		RI	REMTECH	
				w/o	w/o	w/	w/o	w/o	w/
1101	1121.08	343.0		7.08	4.36	5.57	410.8	335.8	413.4
1108	1121.08	348.0		5.55	4.28	5.59	369.1	328.3	409.2
7430	1123.15	0.0		8.36	5.59	7.29	447.2	394.9	497.7
7439	1123.15	180.0		2.24	1.26	1.67	129.2	142.	165.3
7437	1123.15	225.0		2.22	2.18	2.80	156.9	194.5	233.1
7436	1123.15	247.5		1.50	1.46	1.87	129.1	158.1	186.3
7435	1123.15	270.0		1.30	1.49	1.91	124.1	157.6	185.6
7434	1123.15	292.5		1.55	1.70	2.17	134.5	174.7	207.2
7432	1123.15	315.0		6.25	3.40	4.25	296.6	236.0	314.0
7431	1123.15	337.5		4.35	3.19	4.25	260.1	255.5	314.0
56283	1124.50	32.5		4.89	4.23	–	276.1	273.	–

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1
d) DESIGN ENVIRONMENTS FOR THE LH_2 TANK ACREAGE

BODY POINT	COORDINATES		LOCATION	MAX HEATING RATE (BTU/ft^2sec)		HEAT LOAD (BTU/ft^2)	
	X_T (in)	θ_T (deg)		RI	REMTECH	RI	REMTECH
6582	1127.56	23.5	LH_2 Tank Acreage	5.83	2.98	376.8	260.1
7440	1137.29	0.0		6.47	6.29	406.4	478.9
7449	1137.29	180.0		1.10	1.34	101.9	137.5
7447	1137.29	225.0		1.23	1.36	108.8	144.4
7446	1137.29	247.5		1.19	1.38	107.1	149.8
7445	1137.29	270.0		1.07	1.43	102.5	151.5
7444	1137.29	292.5		1.14	1.44	104.5	163.2
7442	1137.29	315.0		2.41	2.59	176.2	205.6
7441	1137.29	337.5		3.33	4.19	240.5	366.1
1115	1139.53	12.0		6.72	5.83	418.6	408.1
1122	1139.53	17.0		6.32	5.74	354.7	403.3
1105	1139.53	343.0		5.30	4.18	371.1	361.1
1110	1139.53	348.0		4.78	4.47	337.1	384.8
56505	1149.99	32.5		8.45	—	399.0	—
50108	1151.80	30.9		2.93	2.80	215.6	250.2
50109	1151.80	30.9		3.04	3.04	223.9	267.5
50111	1151.80	30.9		2.05	2.07	153.4	198.0
7450	1167.21	0.0		4.26	3.86	312.9	367.7
7459	1167.21	180.0		1.72	1.35	112.2	126.3
7457	1167.21	225.0		1.74	1.39	128.3	131.6
7455	1167.21	270.0		1.06	1.38	98.0	137.5
7452	1167.21	315.0		2.16	2.58	163.7	202.5
7451	1167.21	337.5		2.89	2.92	232.2	243.1
7470	1201.51	0.0		2.85	2.68	208.7	213.0
7475	1201.51	270.0		1.66	1.38	124.0	149.6

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1 CONTINUED
d) DESIGN ENVIRONMENTS FOR THE LH_2 TANK ACREAGE

BODY POINT	COORDINATES		LOCATION	MAX HEATING RATE (BTU/ft^2sec)		HEAT LOAD (BTU/ft^2)	
	X_T (in)	θ_T (deg)		RI	REMTECH	RI	REMTECH
56515	1204.74	32.5	LH_2 Tank Acreage	11.63	—	573.8	—
7479	1209.51	180.0		1.84	1.37	111.6	126.5
7480	1229.96	0.0		3.65	3.27	219.2	218.4
6489	1229.96	19.0		4.85	3.78	271.7	293.9
7489	1229.96	180.0		1.88	1.40	112.9	127.8
7485	1229.96	260.0		1.66	1.36	123.4	134.3
56525	1269.24	32.5		10.43	—	554.3	—
50308	1270.20	30.9		5.19	5.06	342.0	381.6
50309	1270.20	30.9		5.50	5.49	361.4	407.1
50311	1270.20	30.9		4.15	3.74	277.4	291.4
7520	1297.83	0.0		3.53	2.28	204.7	197.9
7529	1297.83	180.0		1.91	1.44	112.4	126.9
7525	1297.83	270.0		1.64	1.39	121.5	135.2
6587	1334.37	23.5		1.23	1.88	149.4	173.1
6588	1358.90	23.5		1.59	1.88	172.2	172.3
7550	1359.15	0.0		2.02	1.89	155.4	176.4
6555	1359.15	40.0		1.65	1.15	118.9	130.6
7559	1359.15	180.0		1.38	1.51	105.8	127.0
7557	1359.15	225.0		1.14	1.51	95.3	131.9
7556	1359.15	247.5		1.14	1.35	95.2	130.0
7555	1359.15	270.0		1.63	1.40	120.4	135.7
7554	1359.15	292.5		1.23	1.39	100.4	135.3
7552	1359.15	315.0		1.76	2.54	134.4	195.7
7551	1359.15	337.5		1.31	1.47	127.4	170.5
6589	1366.38	23.5		2.24	2.14	211.0	181.3

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1 CONTINUED
d) DESIGN ENVIRONMENTS FOR THE LH_2 TANK ACREAGE

BODY POINT	COORDINATES		LOCATION	MAX HEATING RATE (BTU/ft^2sec)		HEAT LOAD (BTU/ft^2)	
	X_T (in)	θ_T (deg)		RI	REMTECH	RI	REMTECH
6590	1371.99	23.5	LH_2 Tank Acreage	2.64	2.21	241.7	184.4
6593	1375.26	23.5		3.18	2.25	270.1	186.3
6594	1380.41	23.5		1.09	1.27	139.2	119.9
6595	1383.91	23.5		1.19	1.26	140.7	119.9
6596	1387.65	23.5		1.19	1.26	137.6	119.8
50508	1399.40	30.9		4.21	4.15	303.5	348.6
50509	1399.40	30.9		4.50	4.52	323.2	376.6
50511	1399.40	30.9		2.94	3.07	218.7	265.3
6597	1401.00	23.5		0.94	1.26	118.8	119.6
7620	1486.49	0.0		2.67	1.84	186.6	170.8
7629	1486.49	180.0		2.00	1.55	112.5	127.4
7625	1486.49	270.0		2.47	1.47	147.0	136.9
56534	1591.74	32.5		6.11	—	401.2	—
50808	1593.20	30.9		1.77	2.00	178.5	181.1
50809	1593.20	30.9		2.15	2.17	199.0	194.9
50811	1593.20	30.9		0.93	1.48	105.8	139.6
56535	1597.19	32.5		4.21	—	210.7	—
7690	1615.67	0.0		2.04	1.46	154.3	144.0
6699	1615.67	19.0		3.32	2.34	195.7	212.5
7699	1615.67	180.0		1.84	1.56	119.9	129.4
7697	1615.67	225.0		1.20	1.46	97.6	128.2
7696	1615.67	247.5		1.14	1.31	96.7	123.7
7695	1615.67	270.0		2.04	1.65	137.3	141.0
7694	1615.67	292.5		1.50	2.78	117.1	208.6
7692	1615.67	315.0		1.44	1.69	122.6	150.9

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1 CONTINUED
d) DESIGN ENVIRONMENTS FOR THE LH_2 TANK ACREAGE

BODY POINT	COORDINATES		LOCATION	MAX HEATING RATE (BTU/ft^2sec)		HEAT LOAD (BTU/ft^2)	
	X_T (in)	θ_T (deg)		RI	REMTECH	RI	REMTECH
7691	1615.67	337.5	LH_2 Tank Acreage	1.70	1.42	126.4	151.2
6603	1618.69	23.5		2.60	2.34	213.7	210.4
6606	1621.96	23.5		3.06	2.34	239.5	210.4
7760	1743.02	0.0		1.34	1.30	126.5	136.3
7769	1743.02	180.0		1.73	1.56	113.6	127.8
7767	1743.02	225.0		1.61	1.39	103.4	123.3
7766	1743.02	247.5		1.22	1.32	98.6	122.6
7764	1743.02	292.5		1.87	2.22	125.6	181.0
7762	1743.02	315.0		1.43	1.51	110.5	146.7
7761	1743.02	337.5		1.15	1.30	106.6	145.4
1401	1822.38	309.4		2.63	1.44	214.9	138.9
6614	1865.39	23.5		2.47	2.36	147.9	164.3
1404	1868.51	309.4		4.73	4.61	386.0	251.8
6617	1868.66	23.5		3.39	3.14	197.3	194.2
7830	1872.20	0.0		1.99	2.42	214.3	245.2
7839	1872.20	180.0		1.34	1.38	156.4	175.5
7837	1872.20	225.0		1.38	1.30	159.2	177.3
7836	1872.20	247.5		1.13	1.32	180.9	202.5
7835	1872.20	270.0		3.15	1.46	217.6	232.3
7834	1872.20	292.5		4.24	1.94	203.9	228.7
7832	1872.20	315.0		1.75	1.85	201.2	237.0
7831	1872.20	337.5		1.55	1.27	196.7	214.6
7850	1898.04	0.0		2.77	1.70	235.8	244.8
7859	1898.04	180.0		1.53	1.23	155.9	171.7
7855	1898.04	270.0		1.98	1.88	182.5	197.2

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1 CONTINUED
d) DESIGN ENVIRONMENTS FOR THE LH_2 TANK ACREAGE

BODY POINT	COORDINATES		LOCATION	MAX HEATING RATE (BTU/ft^2sec)		HEAT LOAD (BTU/ft^2)	
	X_T (in)	θ_T (deg)		RI	REMTECH	RI	REMTECH
7852	1898.04	315.0	LH_2 Tank Acreage	2.40	1.79	214.8	212.9
56565	1914.24	32.5		9.89	—	494.0	—
1406	1914.65	304.0		5.39	5.47	305.3	256.7
1409	1914.65	315.0		3.07	2.97	263.5	246.7
51308	1916.00	30.9		2.08	2.17	230.9	273.3
51309	1916.00	30.9		2.24	2.36	238.9	285.8
51311	1916.00	30.9		1.57	1.63	202.8	236.8
1414	1936.79	330.2		3.51	3.74	259.6	286.2
6632	1955.30	23.5		1.11	1.96	210.9	230.4
6633	1962.78	23.5		1.39	2.03	222.4	232.3
6634	1968.39	23.5		1.75	2.08	241.1	233.7
6637	1971.66	23.5		2.96	2.11	280.4	231.6
6638	1976.81	23.5		0.81	1.07	192.5	197.5
56575	1978.74	32.5		9.39	—	460.9	—
6639	1980.31	23.5		0.93	1.07	195.2	197.4
6640	1984.05	23.5		0.91	1.07	193.4	197.3
6909	1999.54	19.0		2.32	2.27	189.4	179.1
51608	2028.00	30.9		6.05	6.50	377.2	421.0
51609	2028.00	30.9		6.38	7.07	391.6	445.7
51611	2028.00	30.9		5.02	4.80	332.6	346.6
1021	2031.65	289.5		5.26	4.65	306.9	298.4
1300	2032.00	355.0		8.42	7.86	398.5	389.1
6647	2033.00	23.5		7.62	7.47	352.0	327.9
6929	2036.45	19.0		11.14	10.60	452.7	374.2
7920	2036.46	0.0		5.88	5.49	341.5	335.5

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 1 CONTINUED
d) DESIGN ENVIRONMENTS FOR THE LH_2 TANK ACREAGE

BODY POINT	COORDINATES		LOCATION	MAX HEATING RATE (BTU/ft^2sec)		HEAT LOAD (BTU/ft^2)	
	X_T (in)	θ_T (deg)		RI	REMTECH	RI	REMTECH
7929	2036.46	180.0	LH_2 Tank Acreage	1.41	1.38	155.4	174.1
7925	2036.46	270.0		3.62	3.57	227.1	280.9
7922	2036.46	315.0		2.00	1.92	229.2	239.1
7921	2036.46	337.5		3.51	2.87	266.1	263.2
1041	2040.75	250.5		3.26	2.65	231.9	257.2
1023	2048.45	289.5		5.21	5.46	289.3	301.2
1043	2048.75	250.5		4.39	3.43	280.0	257.2
1025	2052.65	289.5		9.09	9.14	416.7	388.4
1205	2053.50	312.6		6.97	7.08	425.6	326.2
1303	2053.50	355.0		9.24	9.68	438.6	376.3
1046	2053.75	250.0		6.92	6.76	344.0	302.2
7930	2058.00	0.0		3.02	3.52	250.0	309.4
7939	2058.00	180.0		1.00	1.06	152.0	167.0
7937	2058.00	225.0		1.05	1.24	174.3	175.0
1054	2058.00	247.0		6.49	6.51	308.8	309.0
7935	2058.00	270.0		3.50	6.96	227.8	331.0
1032	2058.00	283.9		8.39	7.00	389.9	361.7
1211	2058.00	319.4		7.99	6.96	379.0	323.6
7931	2058.00	337.5		1.98	6.72	207.5	507.8
1307	2058.00	357.1		9.21	9.41	398.1	355.5
1309	2058.00	358.8		9.34	9.01	396.7	346.8

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between $96 \leq t \leq 126$ seconds, $\dot{q}_{max}$ is listed for $t \leq 95$ seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

TABLE 2 : AEROHEATING AND PLUME CONVECTION MAX HEATING RATE SUMMARY FOR BODY POINT LOCATIONS $X_T \geq 1872$

Body Point	X_T	θ_T	Aeroheating*		Plume Conv.	Method to use when 96 sec $\leq$ t $\leq$ 126 sec
			REMTECH Max Heating Rate	RI Max Heating Rate	RI Max Heating Rate	
7830	1872.20	0.0	2.42	1.99	3.91	Plume Convection
7839	1872.20	180.0	1.38	1.34	3.65	Plume Convection
7837	1872.20	225.0	1.30	1.38	3.65	Plume Convection
7836	1872.20	247.5	1.32	1.13	3.91	Plume Convection
7835	1872.20	270.0	1.46	3.15	3.91	Plume Convection
7834	1872.20	292.5	1.94	4.24	3.91	Aeroheating
7832	1872.20	315.0	1.85	1.75	3.91	Plume Convection
7831	1872.20	337.5	1.27	1.55	3.91	Plume Convection
7850	1898.04	0.0	1.70	2.77	3.91	Plume Convection
7859	1898.04	180.0	1.23	1.53	3.65	Plume Convection
7855	1898.04	270.0	1.88	1.98	3.65	Plume Convection
7852	1898.04	315.0	1.79	2.40	3.65	Plume Convection
1406	1914.65	304.0	5.47	5.39	3.91	Aeroheating
1409	1914.65	315.0	2.97	3.07	3.91	Plume Convection
51308	1916.00	30.9	2.17	2.08	3.91	Plume Convection
51309	1916.00	30.9	2.36	2.24	3.91	Plume Convection
51311	1916.00	30.9	1.63	1.57	3.91	Plume Convection
1414	1936.79	330.2	3.74	3.51	3.91	Plume Convection
6632	1955.30	23.5	1.96	1.11	3.91	Plume Convection
6633	1962.78	23.5	2.03	1.39	3.91	Plume Convection
6634	1968.39	23.5	2.08	1.75	3.91	Plume Convection
6637	1971.66	23.5	2.11	2.96	3.91	Plume Convection
6638	1976.81	23.5	1.07	0.81	3.91	Plume Convection
6639	1980.31	23.5	1.07	0.93	3.91	Plume Convection
6640	1984.05	23.5	1.07	0.91	3.91	Plume Convection
6909	1999.54	19.0	2.27	2.32	—	Aeroheating
51608	2028.00	30.9	6.50	6.05	3.91	Plume Convection

TABLE 2 CONC:
AEROHEATING AND PLUME CONVECTION MAX HEATING RATE SUMMARY FOR BODY POINT LOCATIONS $X_T \geq 1872$

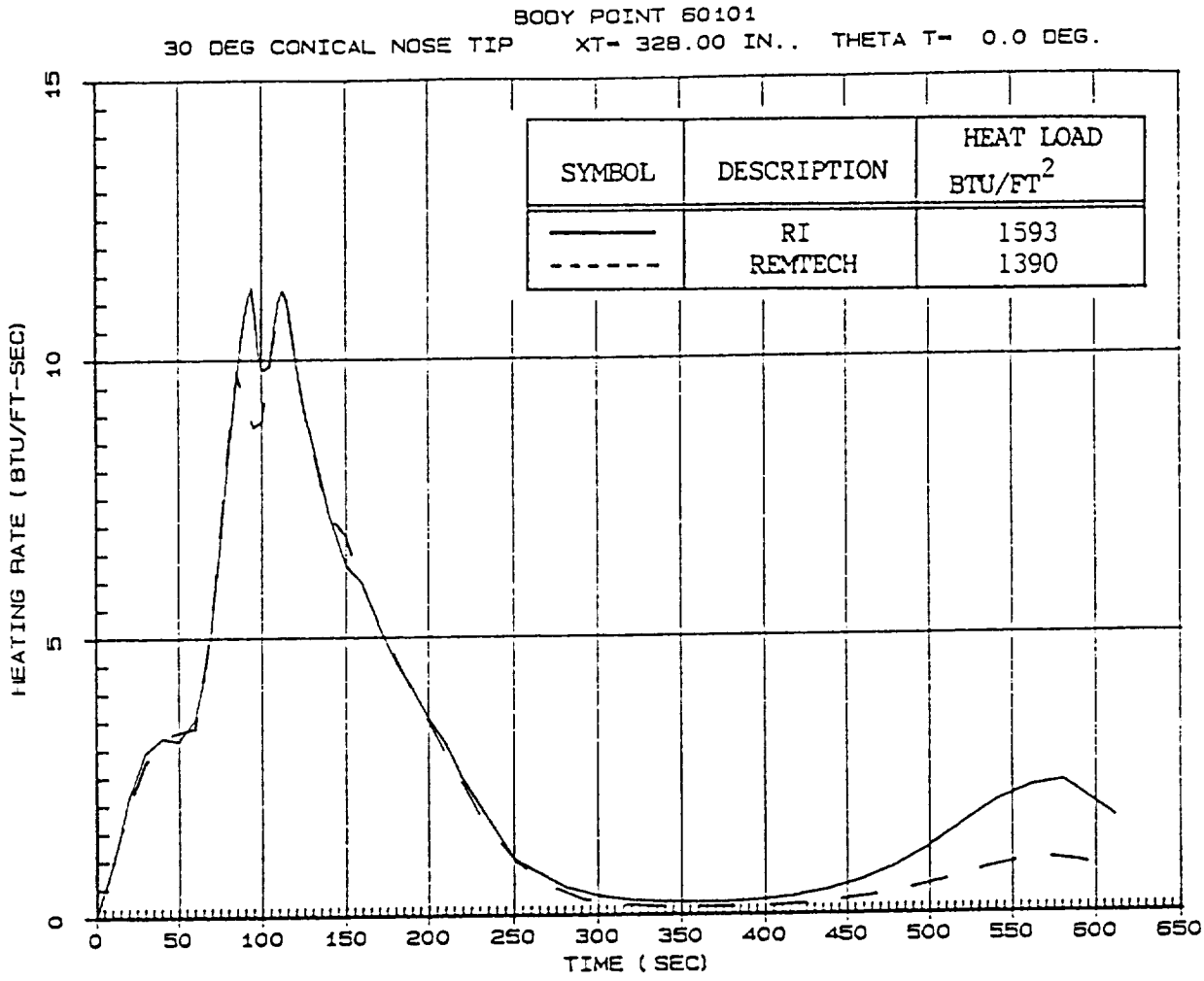
Body Point	X_T	θ_T	Aeroheating*		Plume Conv.	Method to use when 96 sec $\leq$ t $\leq$ 126 sec
			REMTECH Max Heating Rate	RI Max Heating Rate	RI Max Heating Rate	
51609	2028.00	30.9	7.07	6.38	3.91	Plume Convection
51611	2028.00	30.9	4.80	5.02	3.91	Plume Convection
1021	2031.65	289.5	4.65	5.26	3.91	Plume Convection
1300	2032.00	355.0	7.86	8.42	3.91	Plume Convection
6647	2033.00	23.5	7.47	7.62	3.91	Plume Convection
6929	2036.45	19.0	10.60	11.14	3.91	Plume Convection
7920	2036.46	0.0	5.49	5.88	3.91	Plume Convection
7929	2036.46	180.0	1.38	1.41	3.65	Plume Convection
7925	2036.46	270.0	3.57	3.62	3.91	Plume Convection
7922	2036.46	315.0	1.92	2.00	3.91	Plume Convection
7921	2036.46	337.5	2.87	3.51	3.91	Plume Convection
1041	2040.76	250.5	2.65	3.26	3.91	Plume Convection
1023	2048.45	289.5	5.46	5.21	3.91	Plume Convection
1043	2048.75	250.5	3.43	4.39	3.91	Plume Convection
1025	2052.65	289.5	9.14	9.09	3.91	Plume Convection
1205	2053.50	312.6	7.08	6.97	3.91	Plume Convection
1303	2053.50	355.0	9.68	9.24	3.91	Plume Convection
1046	2053.75	250.5	6.76	6.92	3.91	Plume Convection
7930	2058.00	0.0	3.52	3.02	3.91	Plume Convection
7939	2058.00	180.0	1.06	1.00	3.65	Plume Convection
7937	2058.00	225.0	1.24	1.05	3.65	Plume Convection
1054	2058.00	247.0	6.51	6.49	3.91	Plume Convection
7935	2058.00	270.0	6.96	3.50	3.91	Plume Convection
1032	2058.00	283.9	7.00	8.39	3.91	Plume Convection
1211	2058.00	319.4	6.96	7.99	3.91	Plume Convection
7931	2058.00	337.5	6.72	1.98	3.91	Plume Convection
1307	2058.00	357.1	9.41	9.21	3.91	Plume Convection
1309	2058.00	358.8	9.01	9.34	3.91	Plume Convection

* Note: The aeroheating max. heating rates are for time $\leq$ 95 seconds.

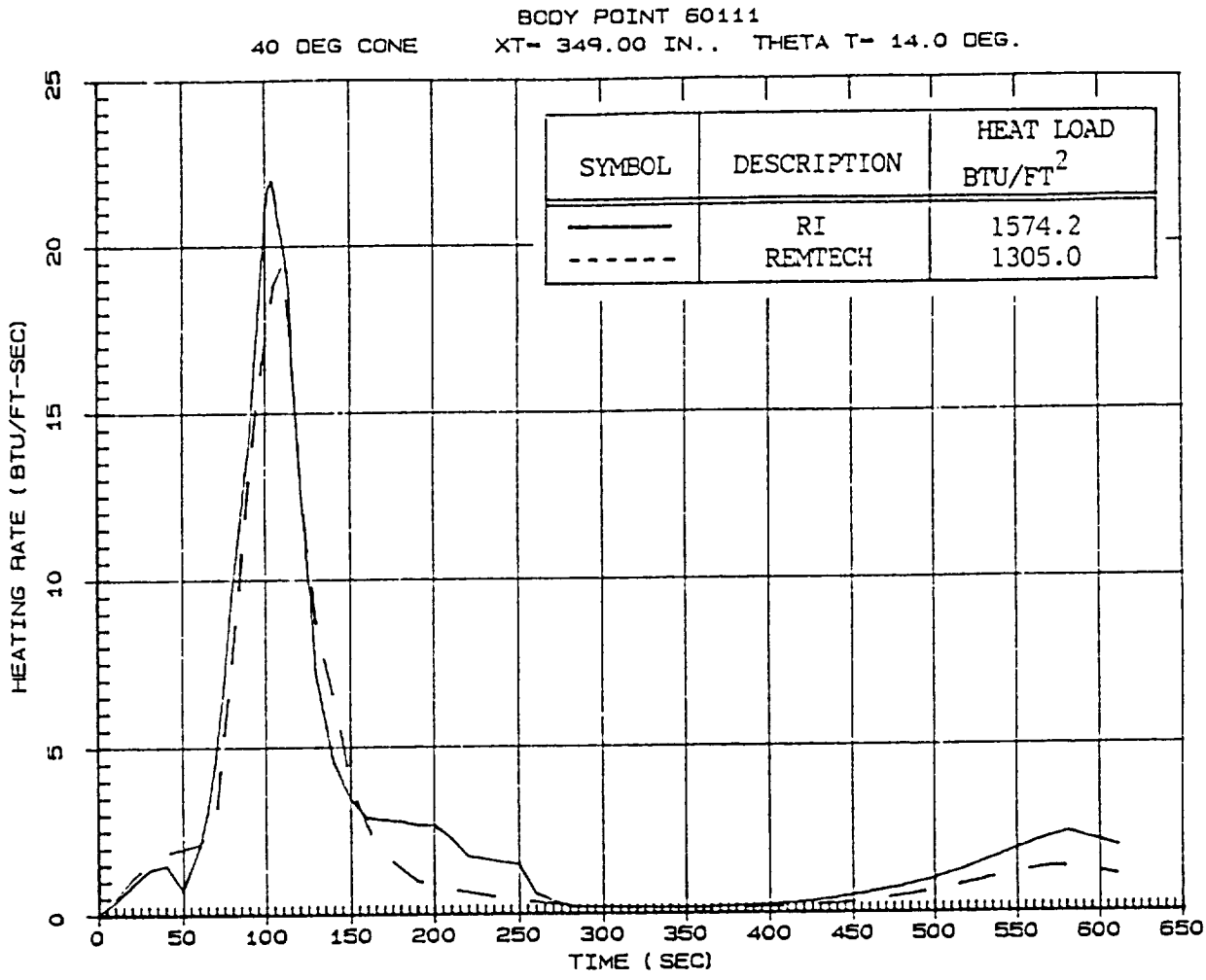
PLOTTED DATA TIMEWISE COMPARISON OF REMTECH/ROCKWELL IVBC-3 ASCENT DESIGN HEATING RATES (TW = 460°R)

Note: The tabulated heat loads include plume convection for body point locations at $X_T \geq 1871$.

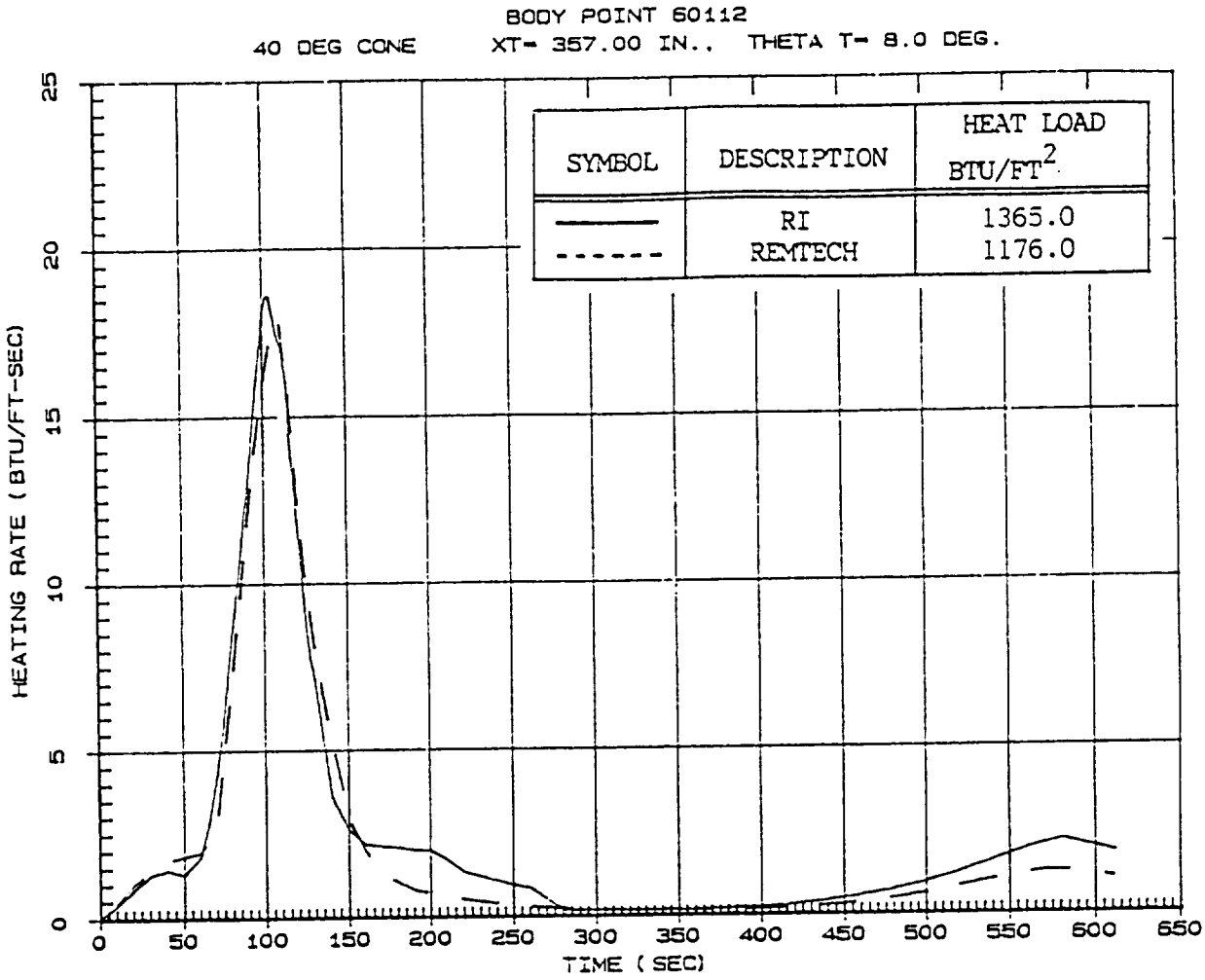
ASCENT DESIGN ENVIRONMENTS FOR THE ET NOSE SPIKE AND 40 DEG CONE ACREAGE BODY POINTS



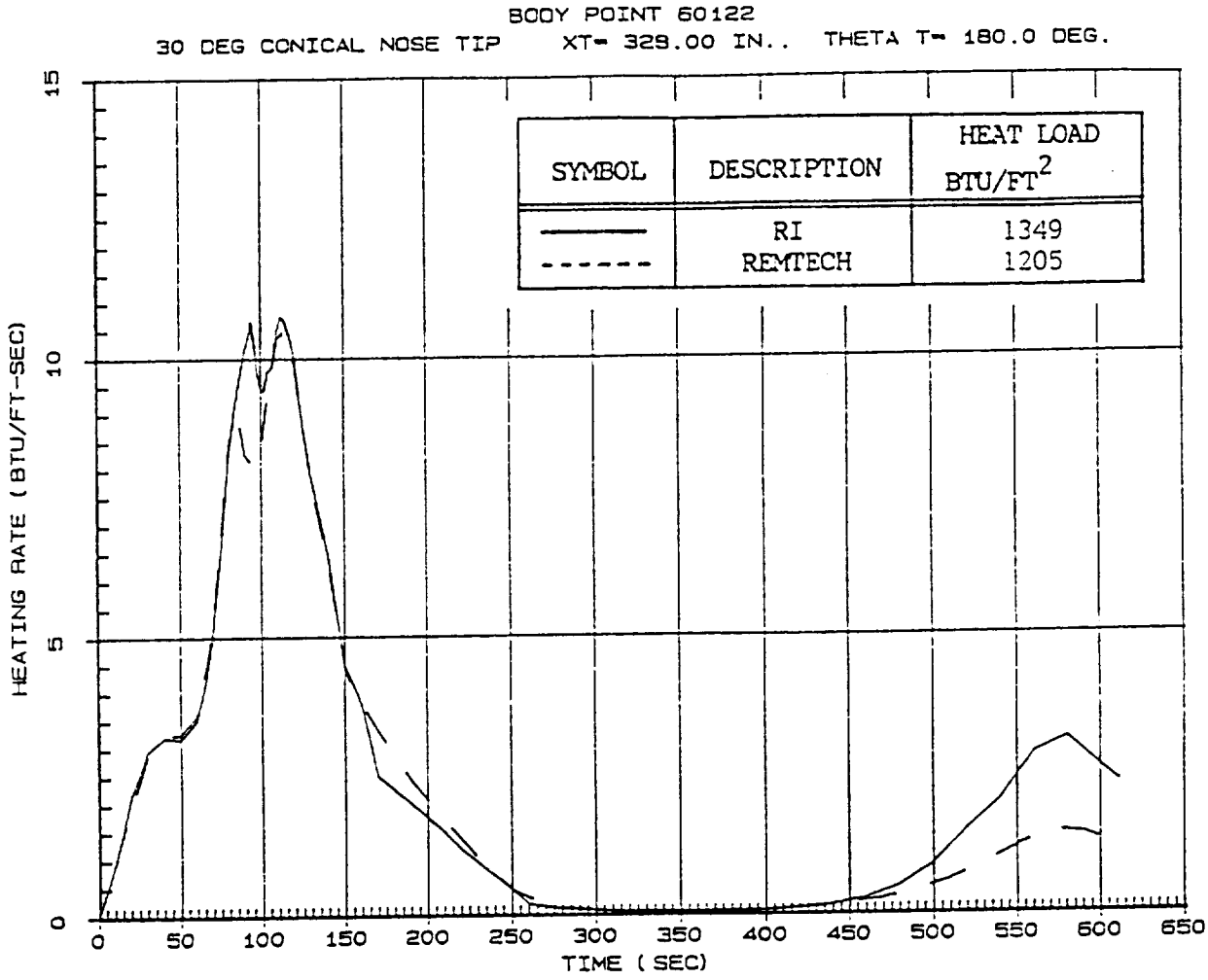
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



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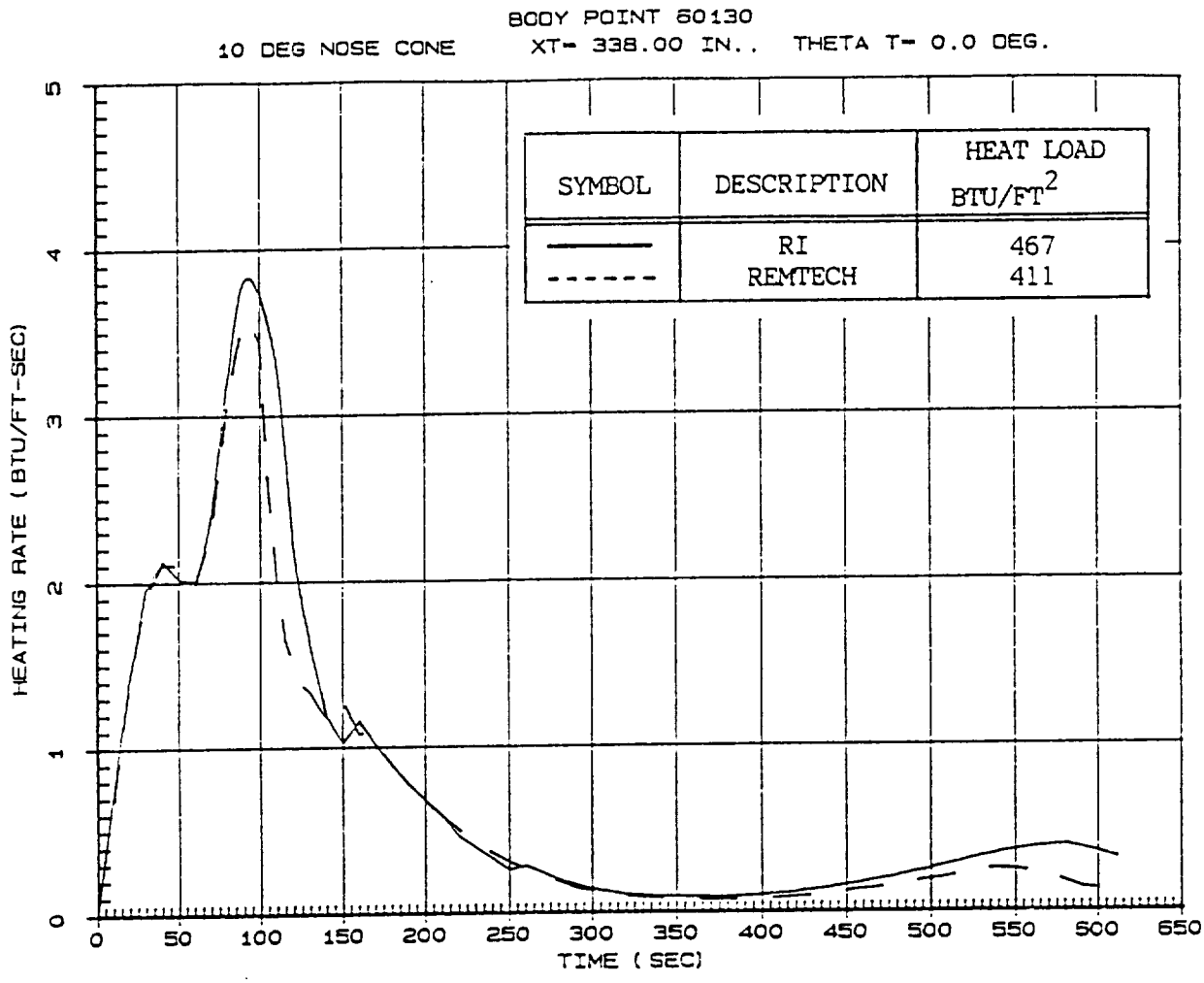
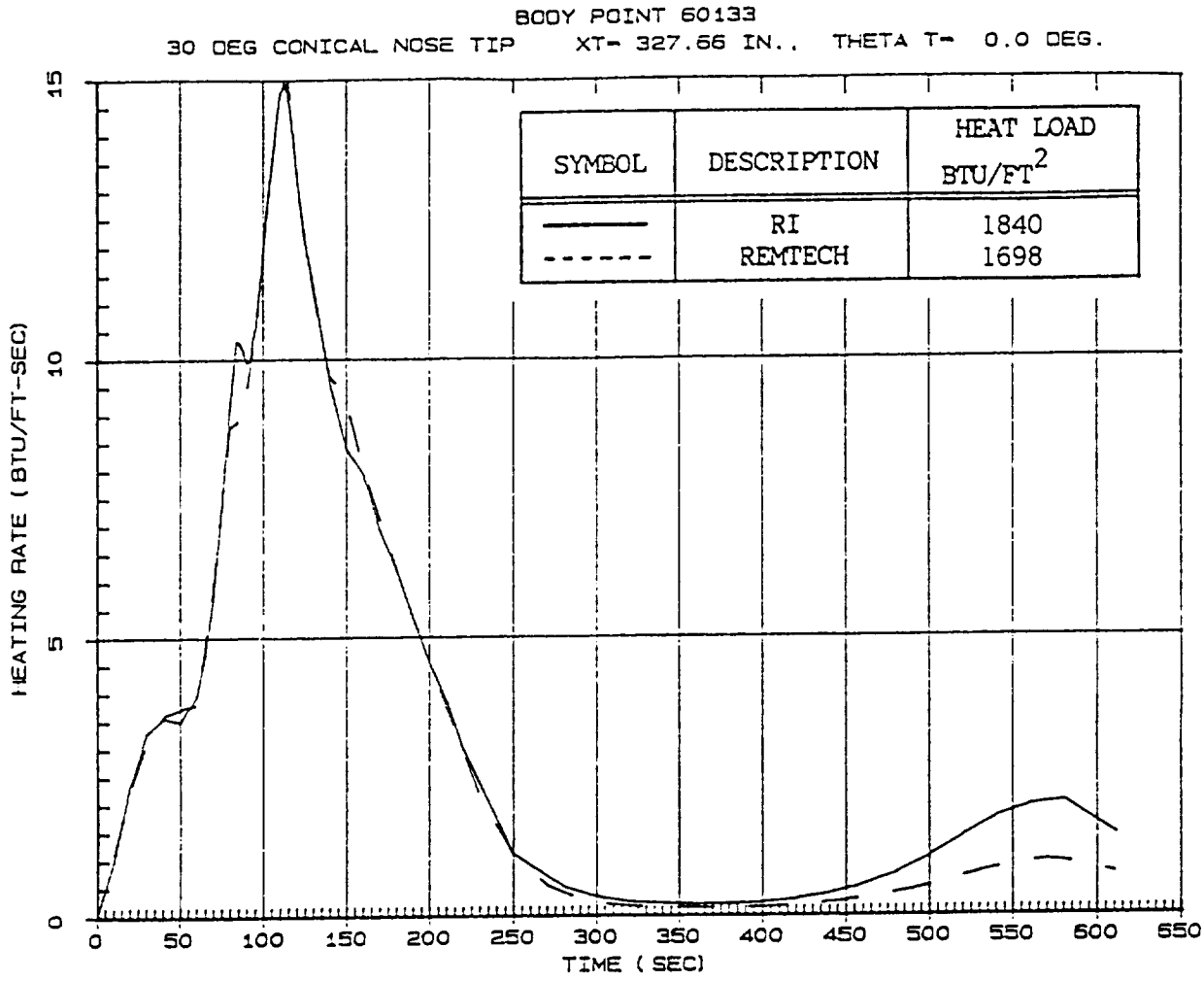


Agreement is acceptable; no TPS impact.



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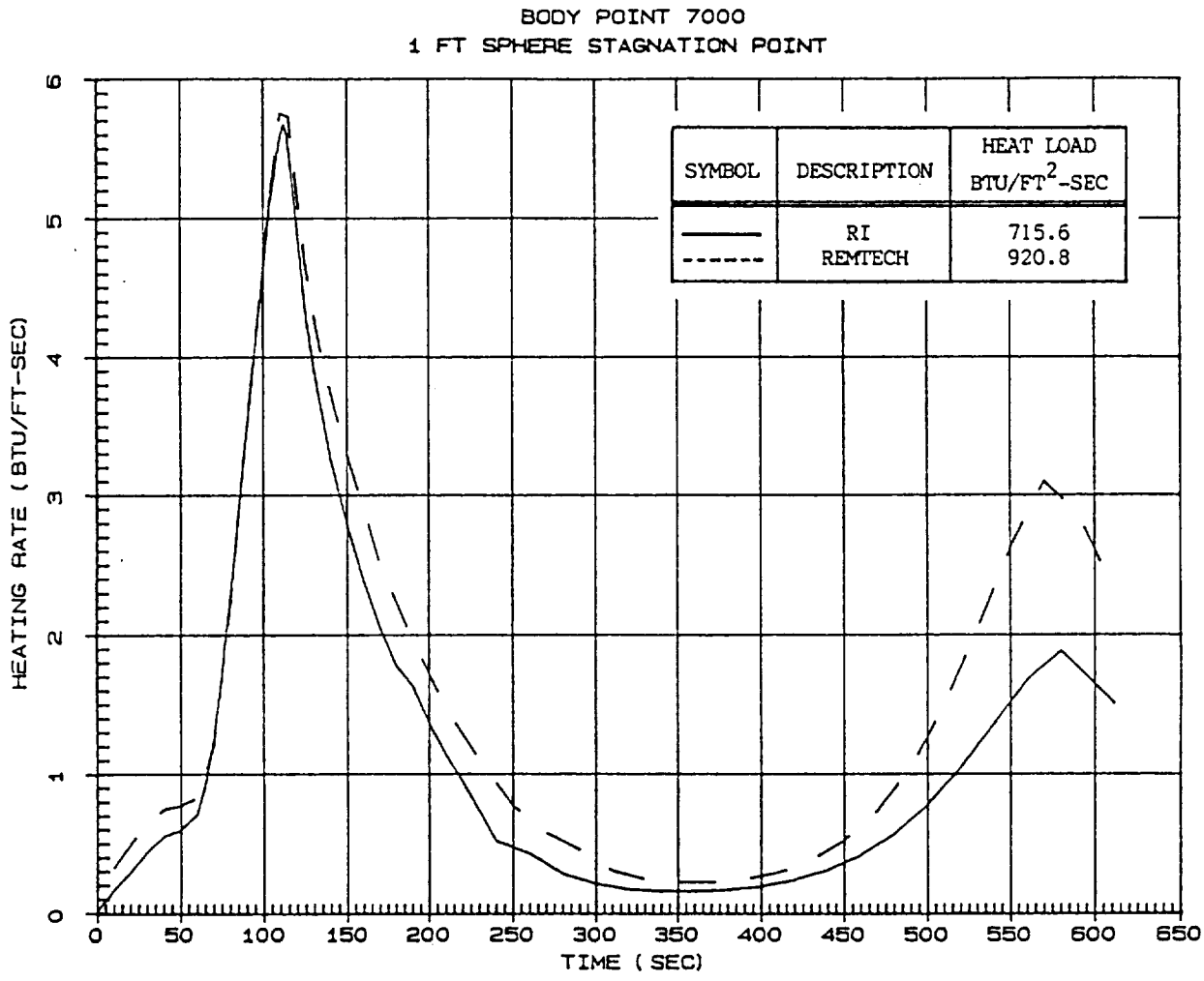
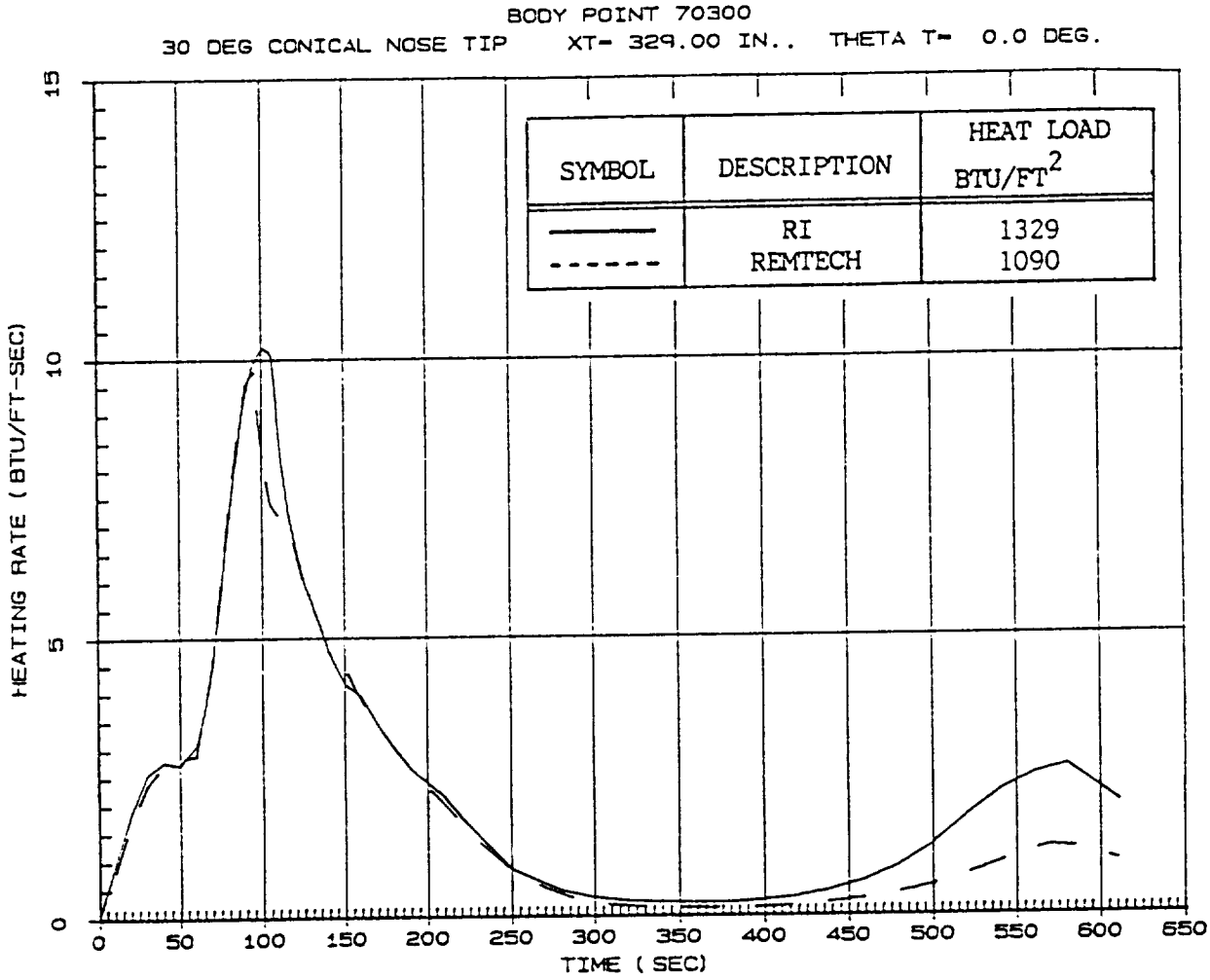
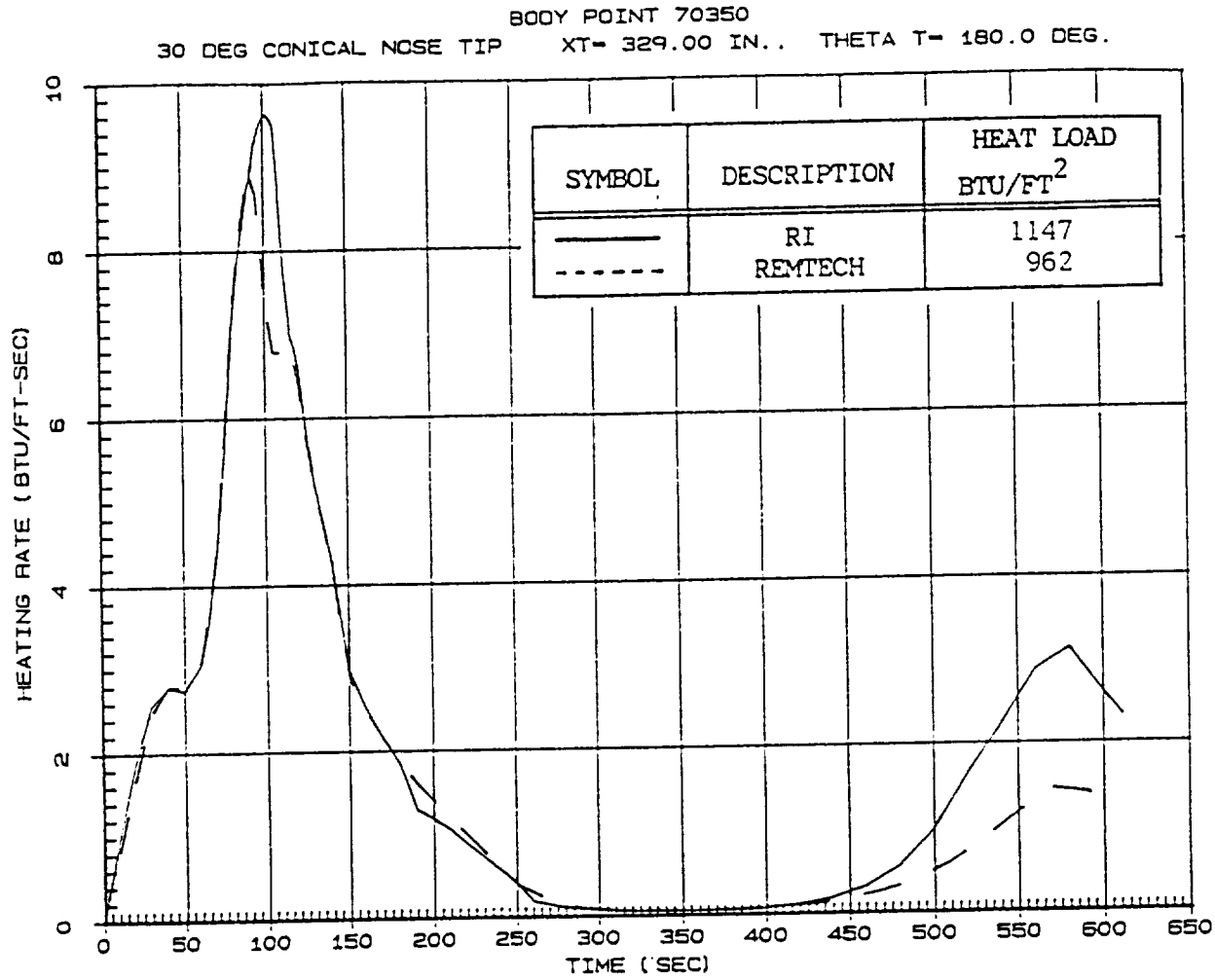


COMMENTS

- Acceptable agreement between RI and REMTECH heating rates during first stage flight
- Difference between RI and REMTECH during second stage flight is unacceptable
- Problem analyzed and conlusion was that RI values are incorrectly low during second stage flight



Agreement is acceptable; no TPS impact.



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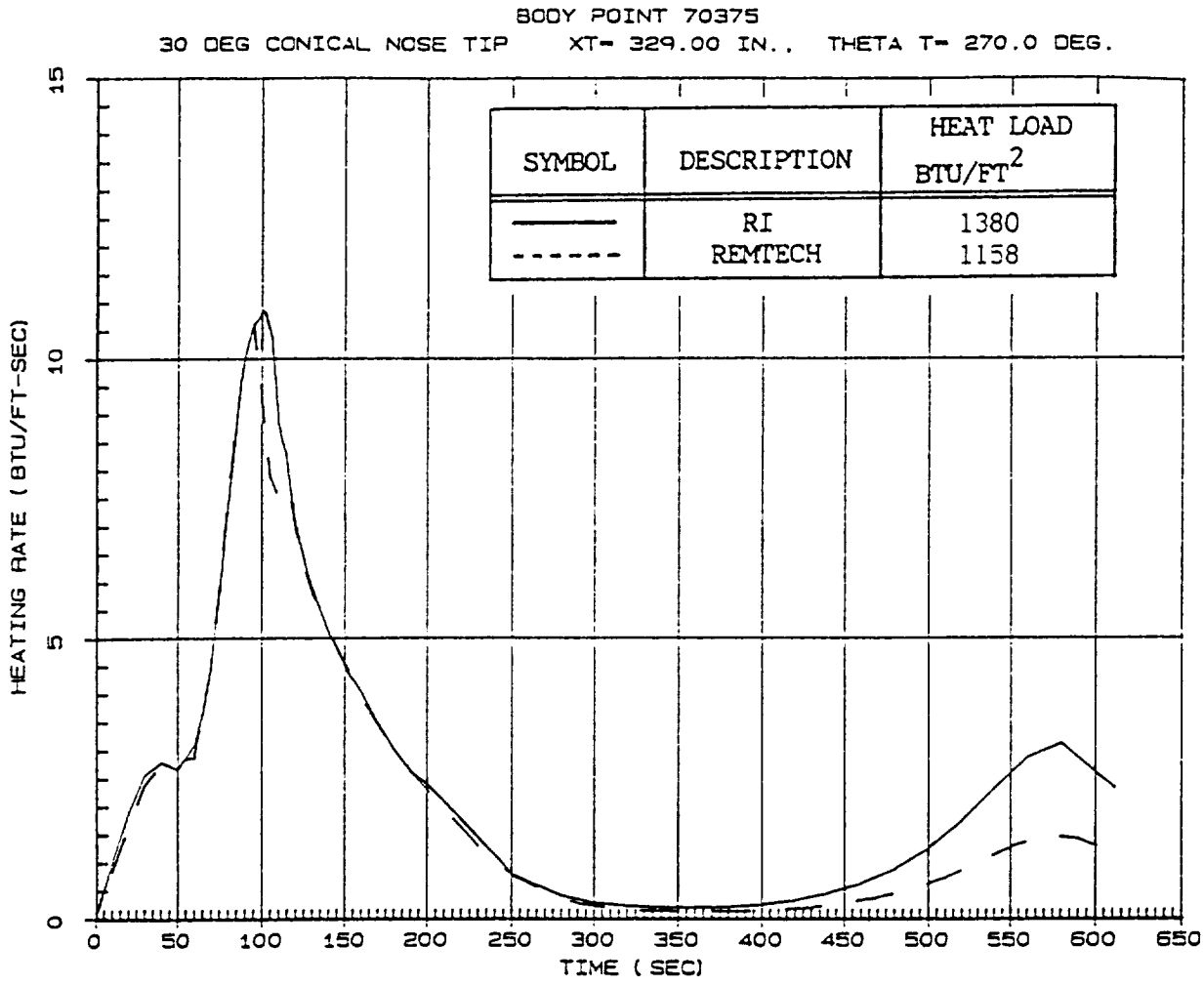
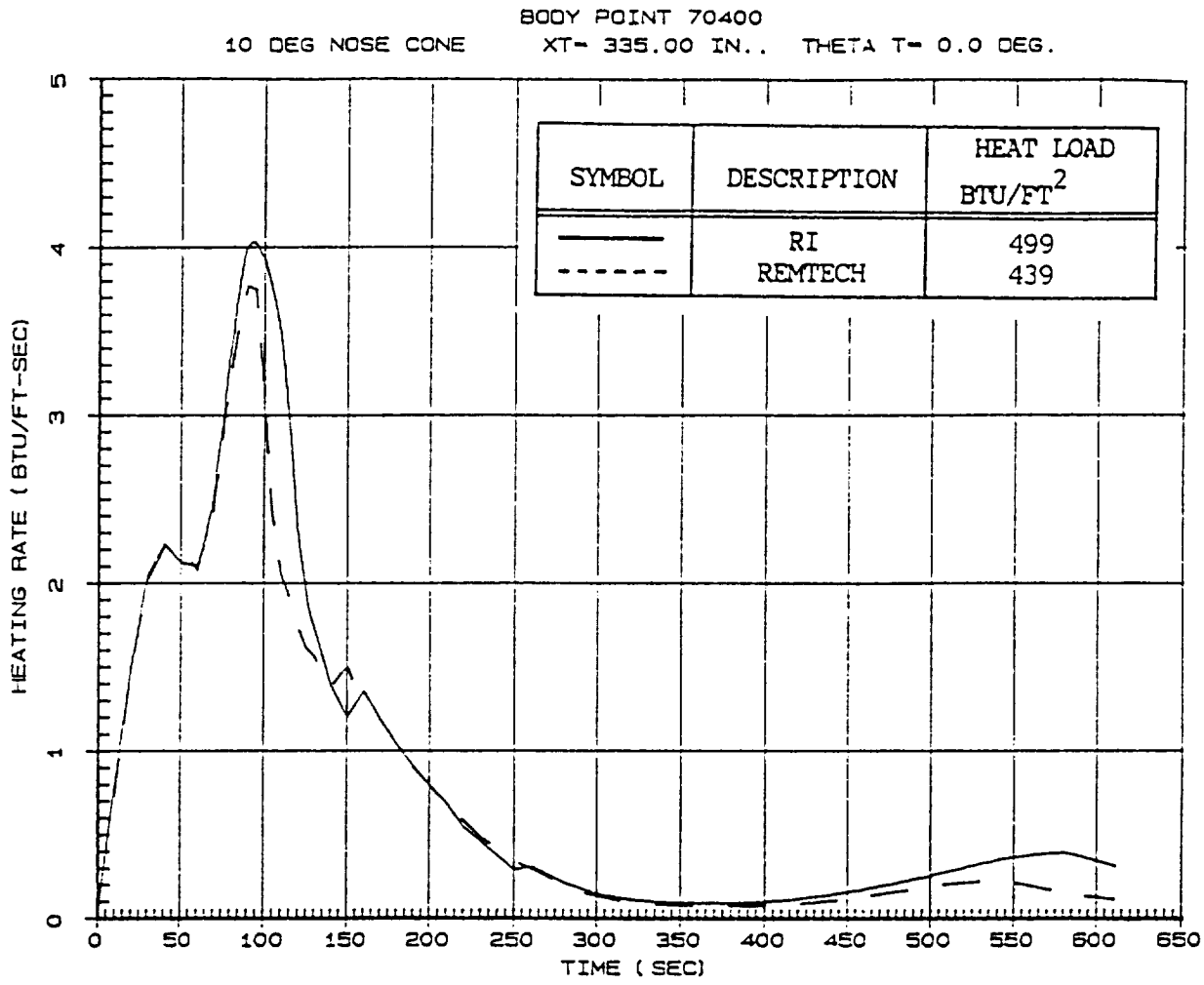


Agreement is acceptable; no TPS impact.



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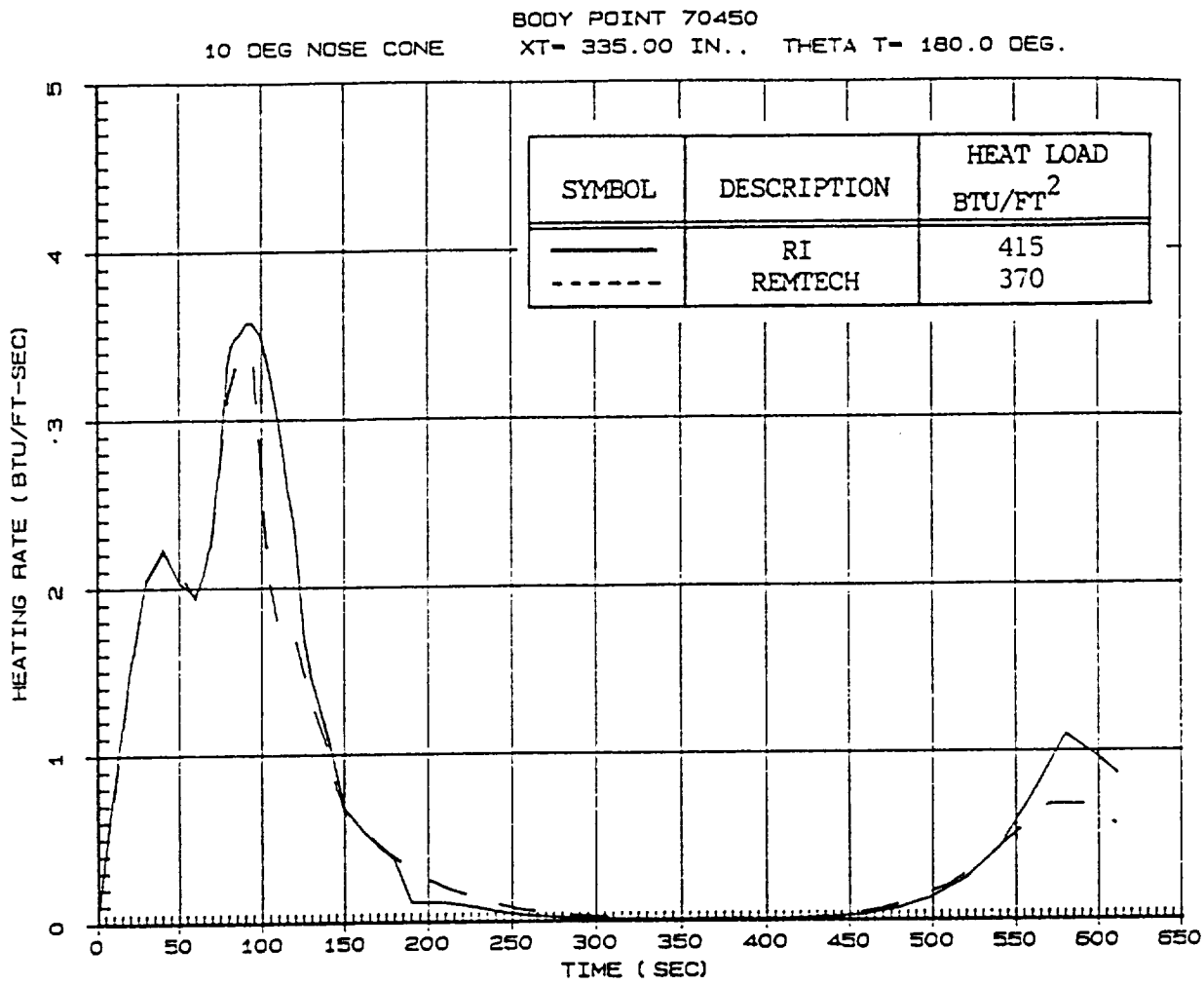
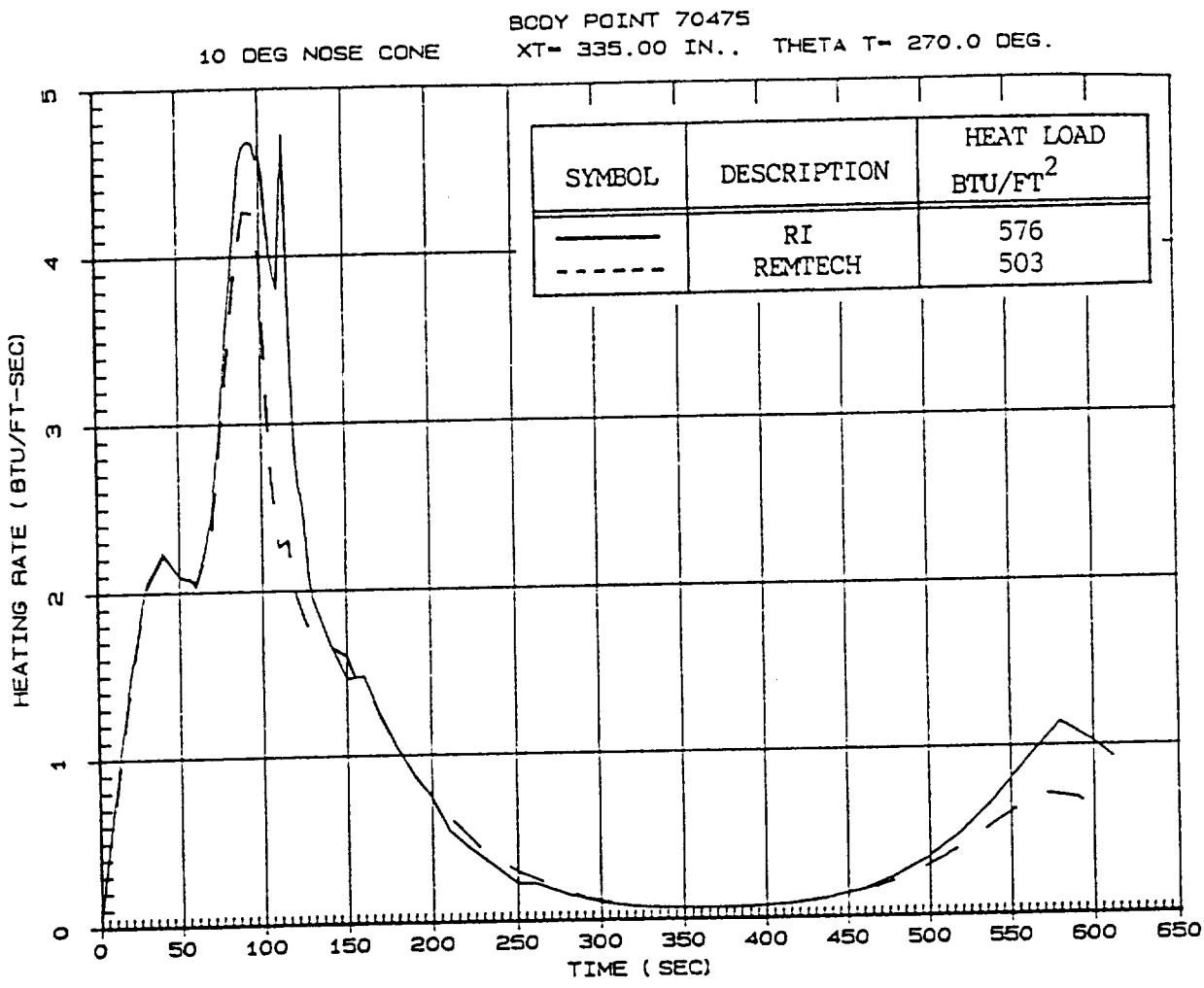
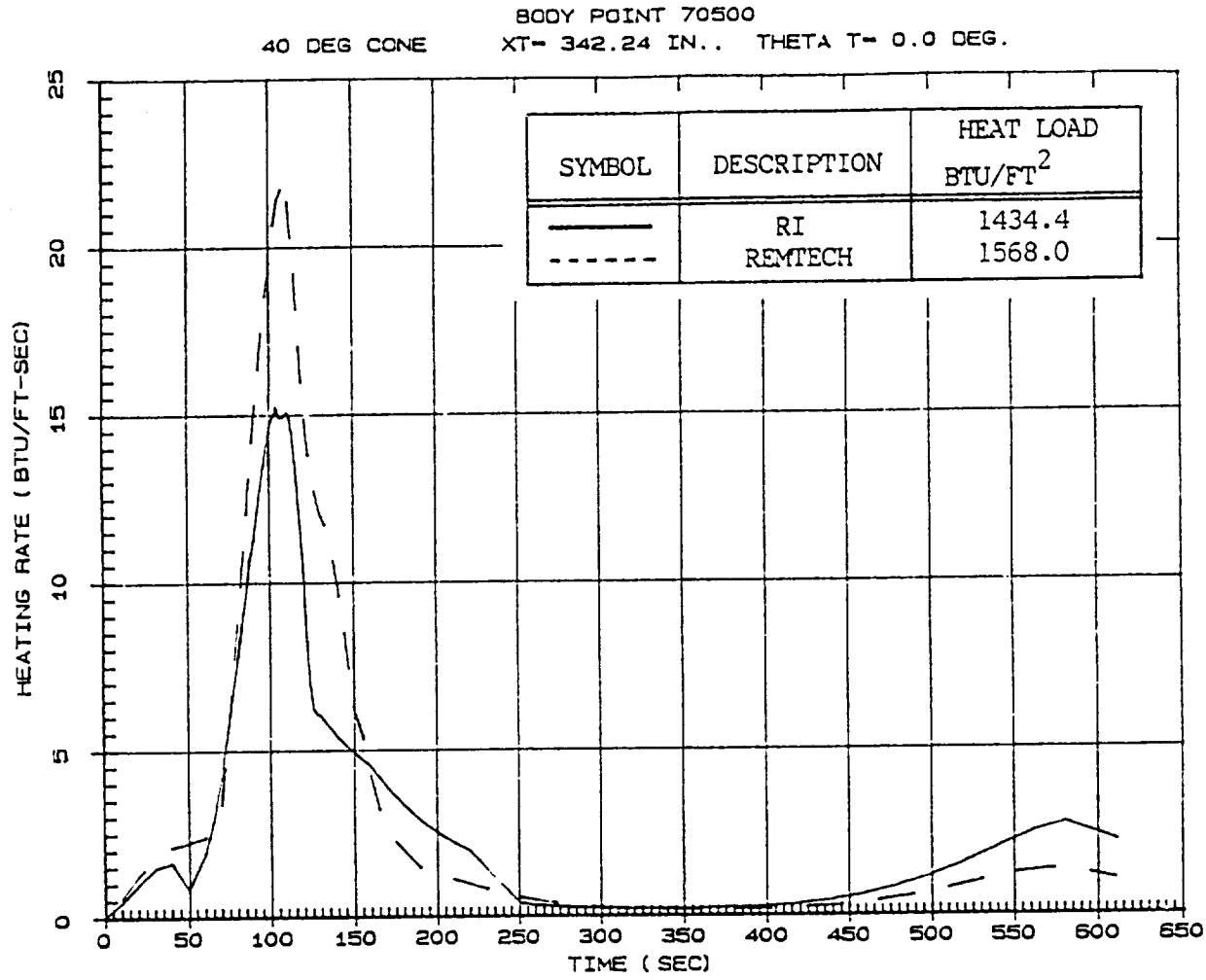


Agreement is acceptable; no TPS impact.

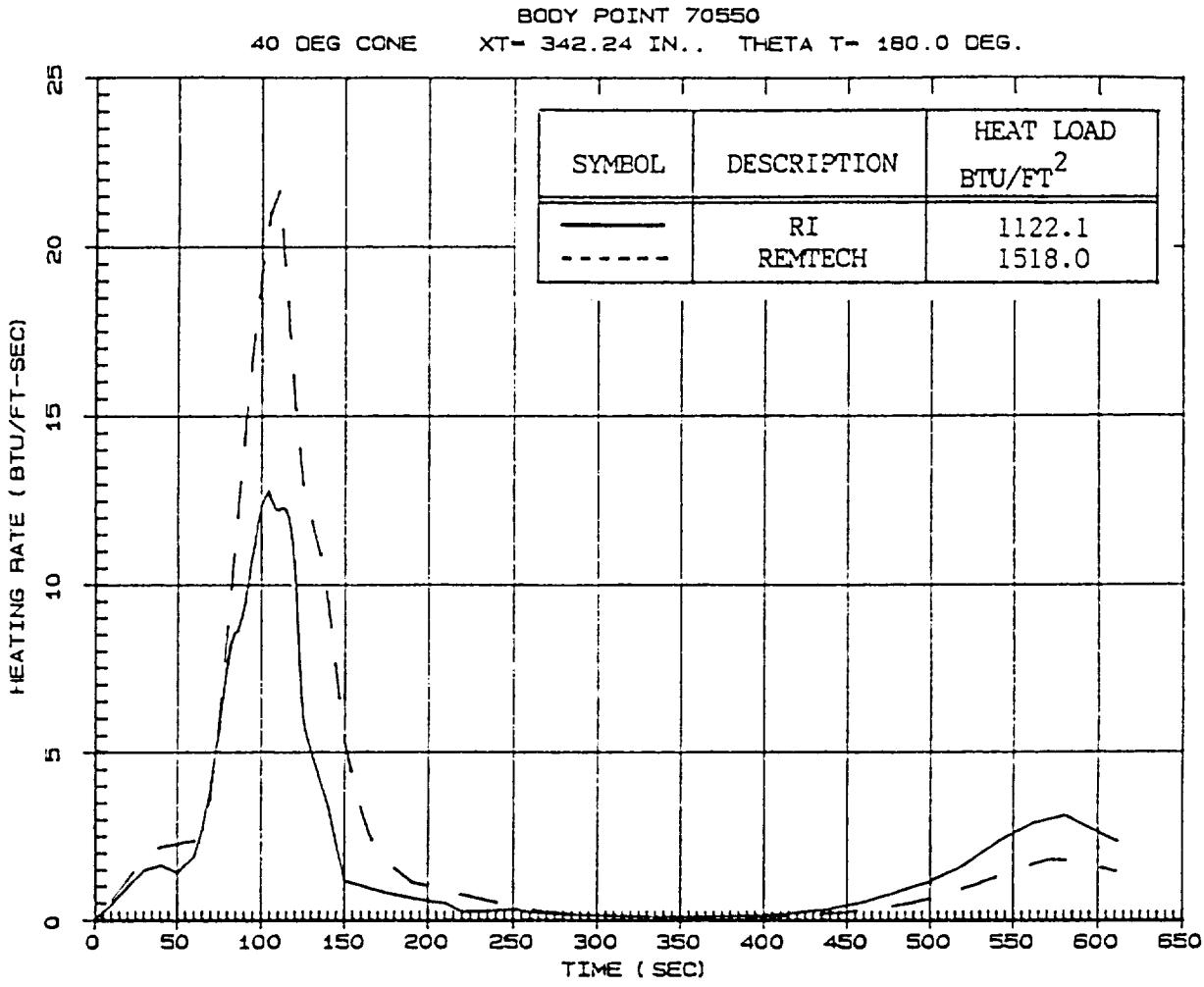


Agreement is acceptable; no TPS impact.



COMMENTS

- REMTECH environment includes nose spike interference effects that were based on six sets of flight data measured at one location (X_T = 350, θ_T = 180°)
- Wind tunnel data was laminar/transitional whereas flight data appeared to be transitional/turbulent
- REMTECH environments assumed that the heating amplification factor over the entire 40° cone surface is constant
- RI environments based on wind tunnel distributions which measured low heating levels for $X_T < 350$
- Difference between RI and REMTECH environments should not impact current TPS design



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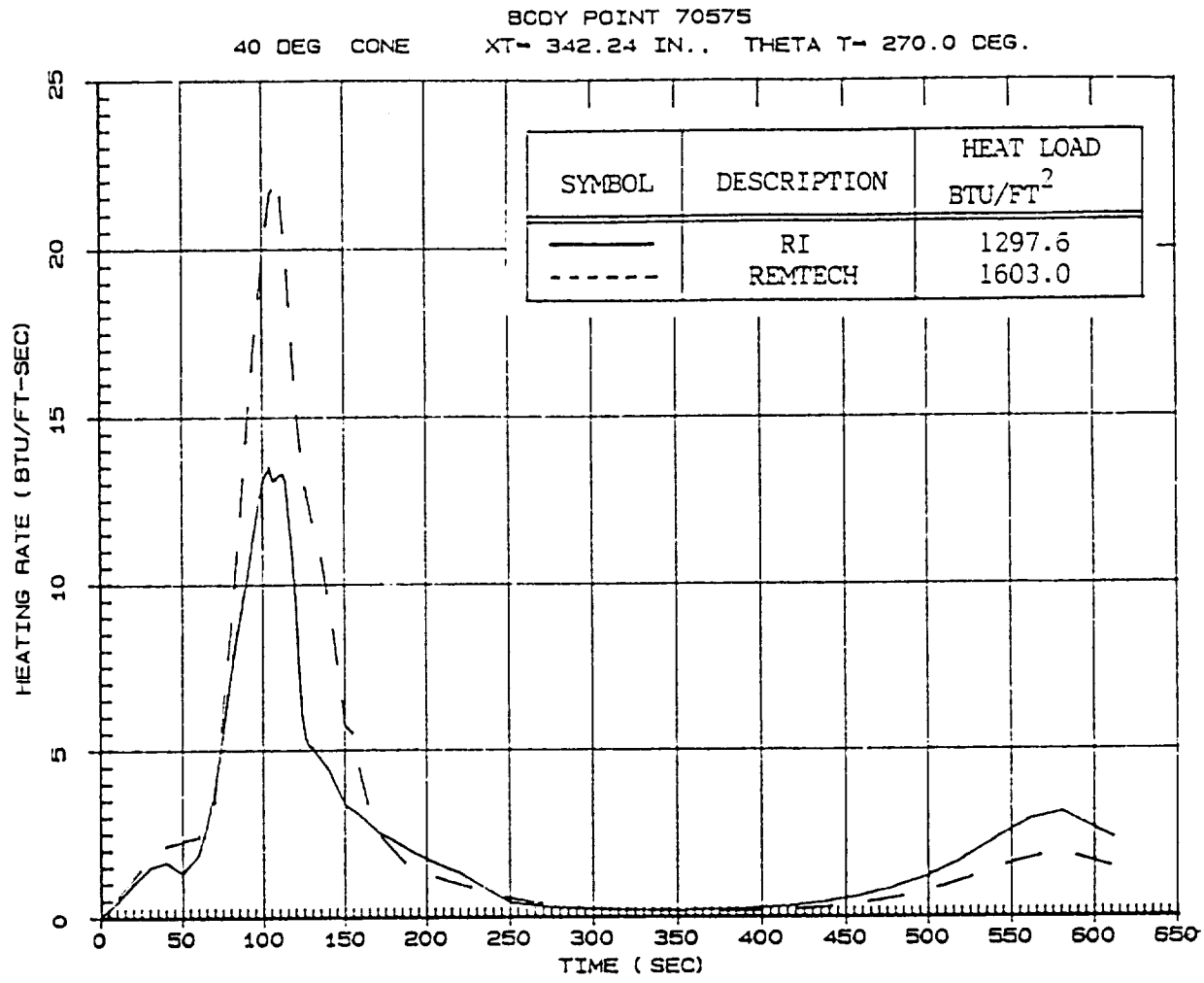

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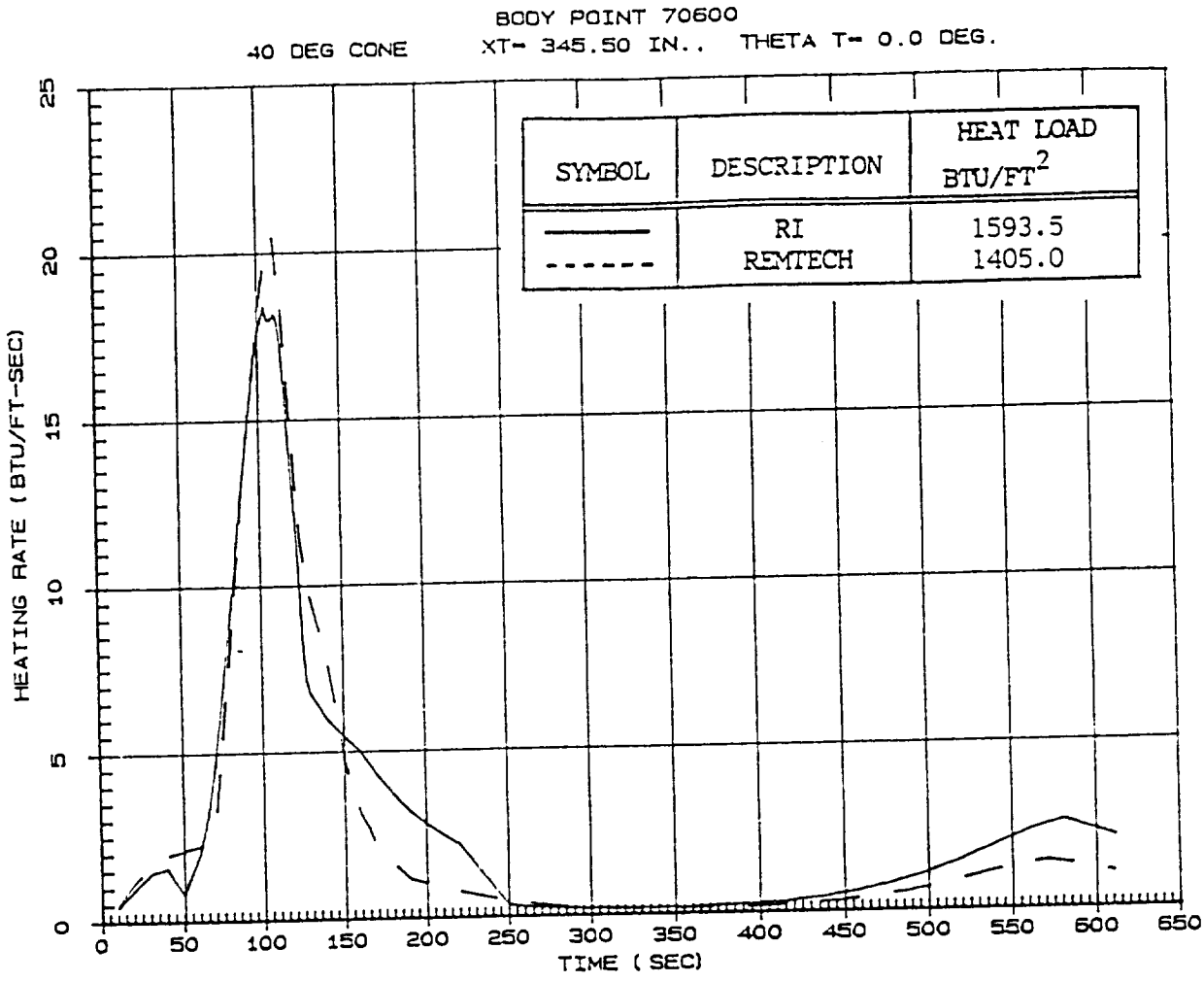

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- Wind tunnel data was laminar/transitional whereas flight data appeared to be transitional/turbulent
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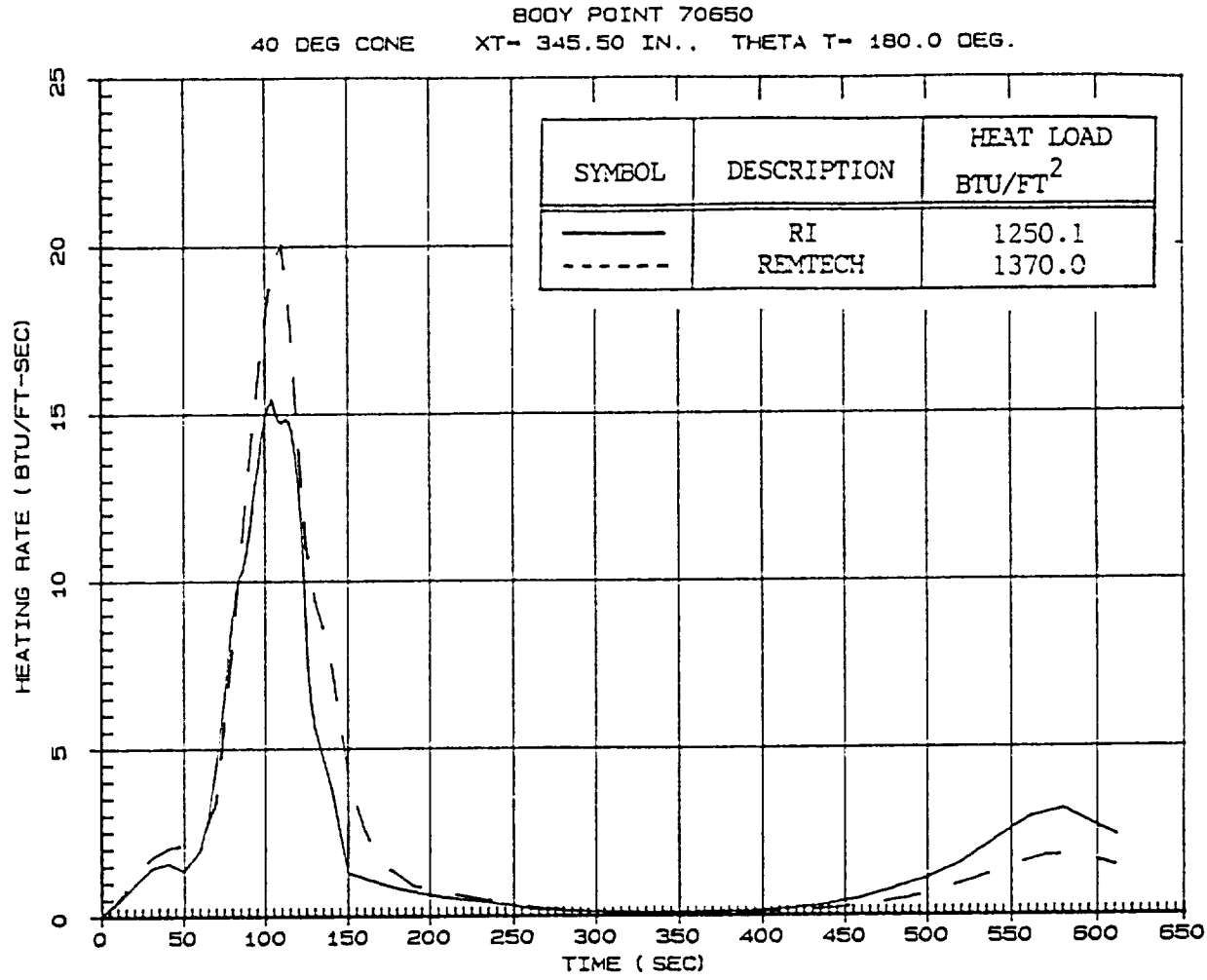

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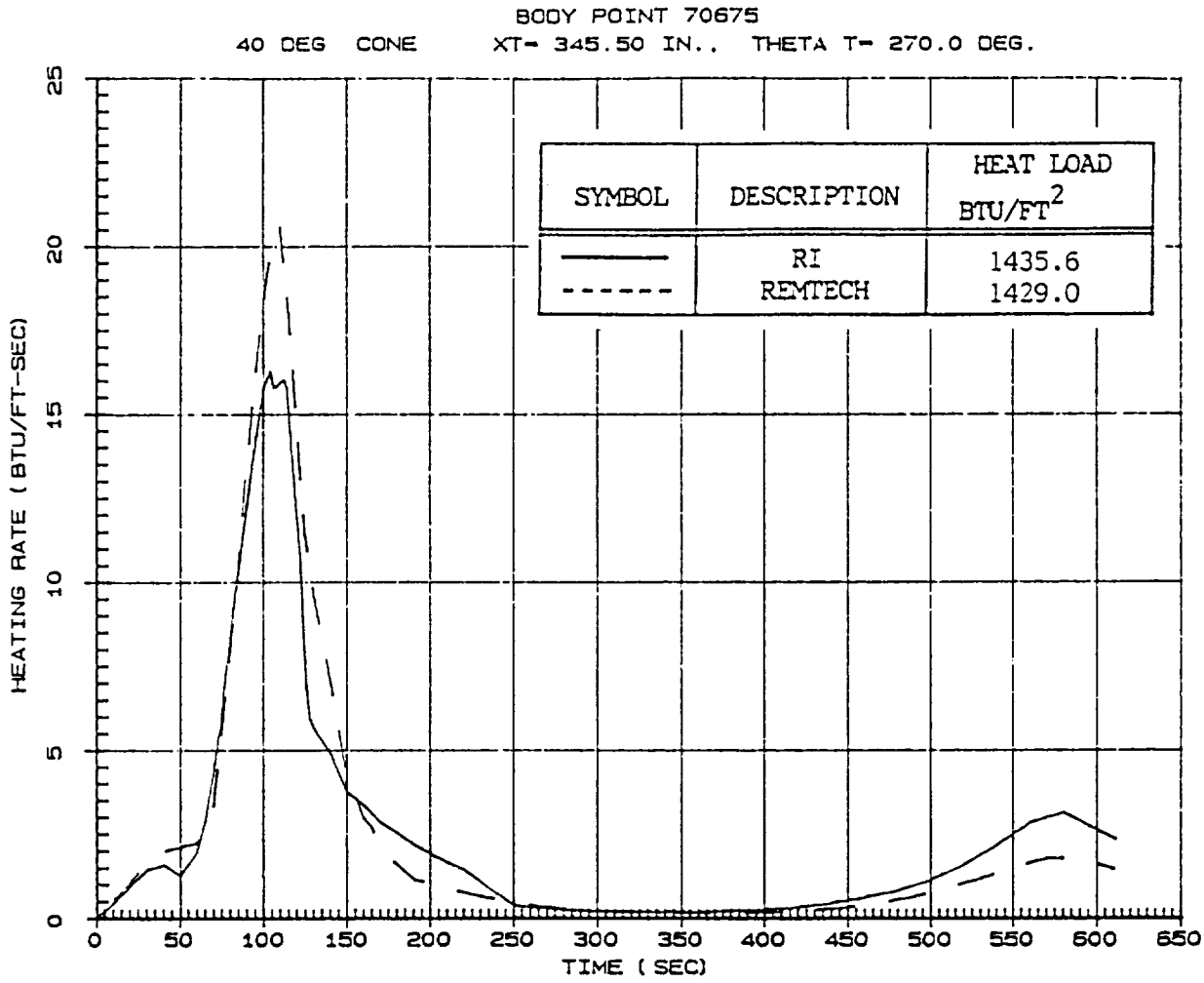

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- REMTECH environment includes nose spike interference effects that were based on six sets of flight data measured at one location (X_T = 350, θ_T = 180°)
- Wind tunnel data was laminar/transitional whereas flight data appeared to be transitional/turbulent
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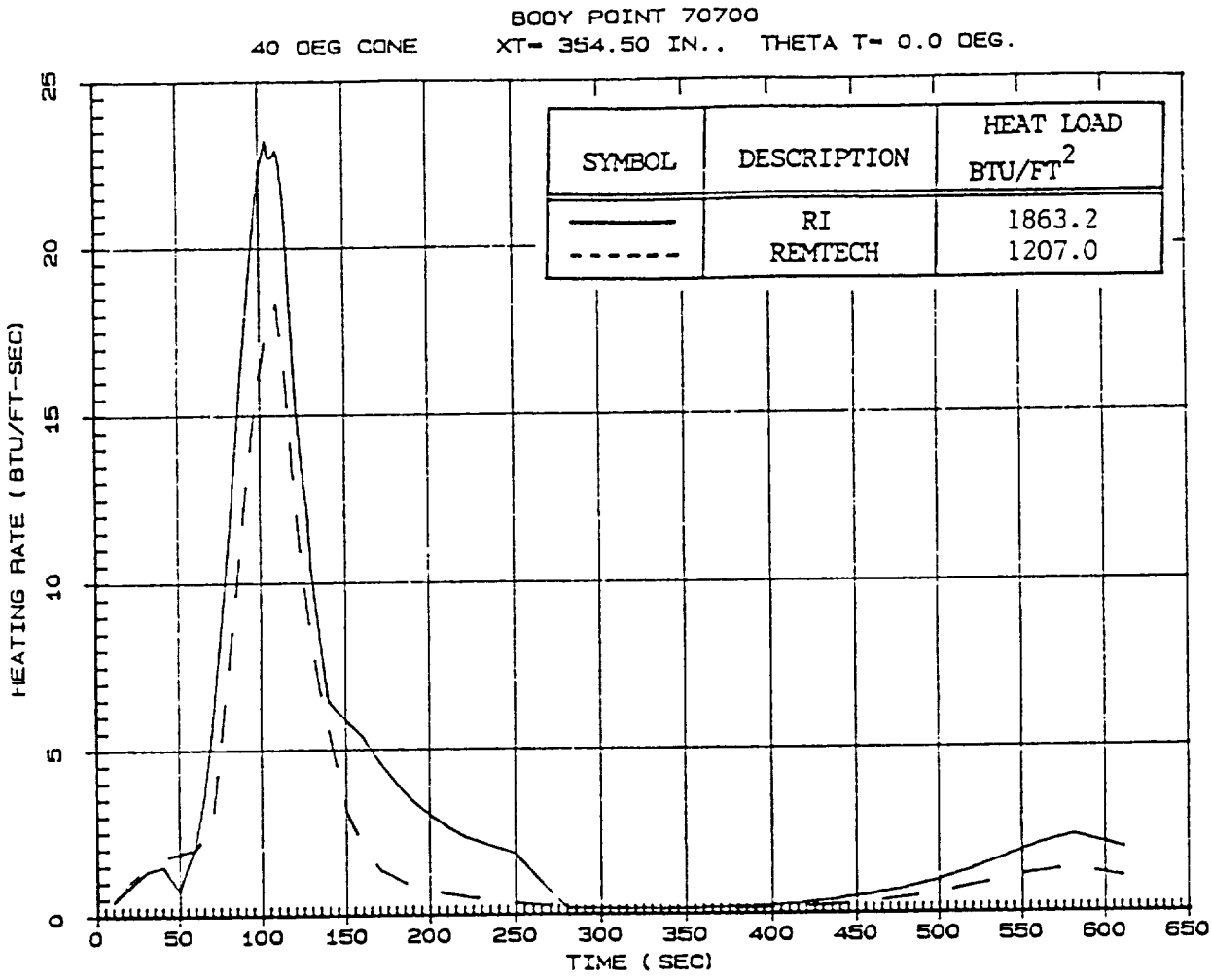
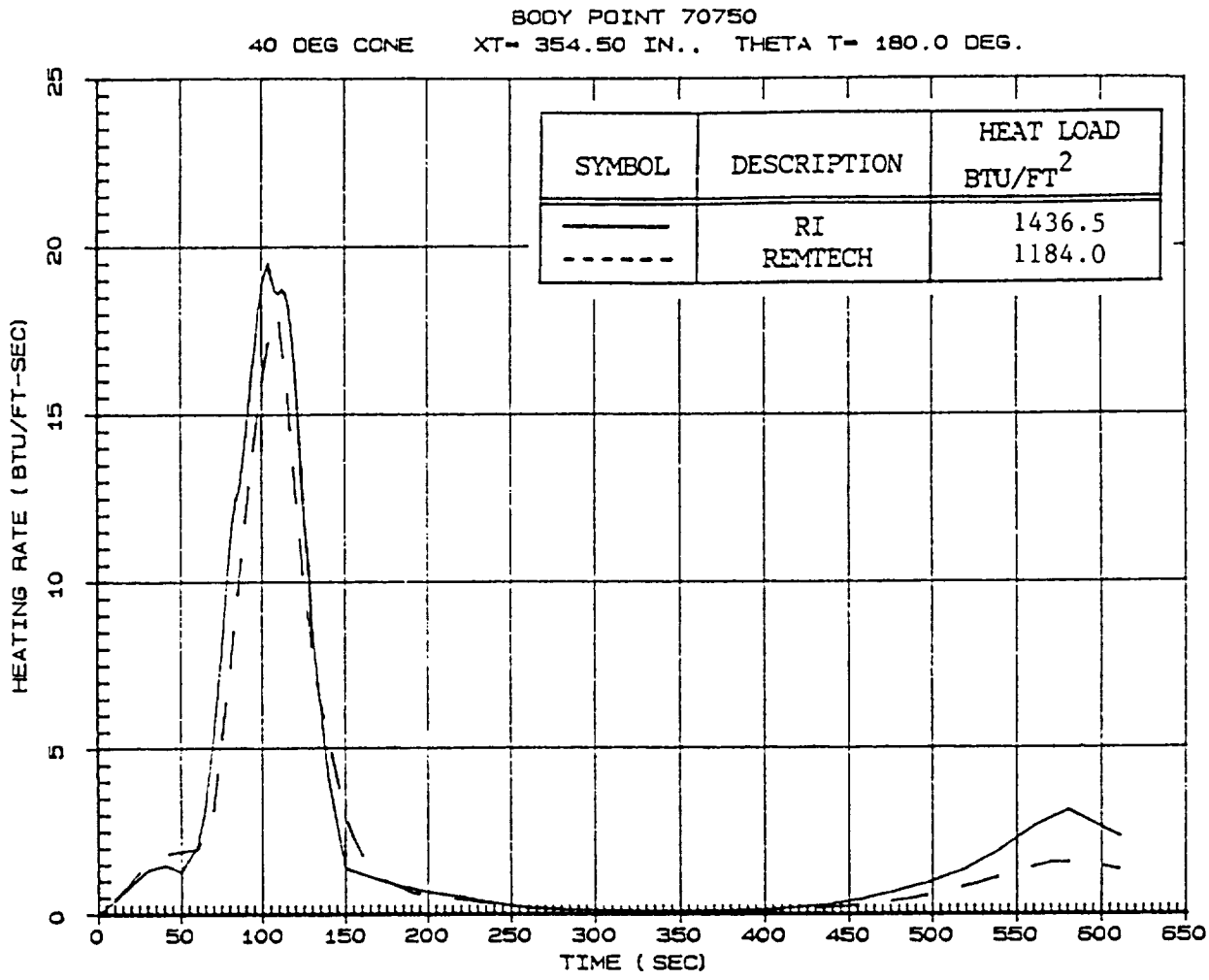
- Difference between RI and REMTECH environments should not impact current TPS design

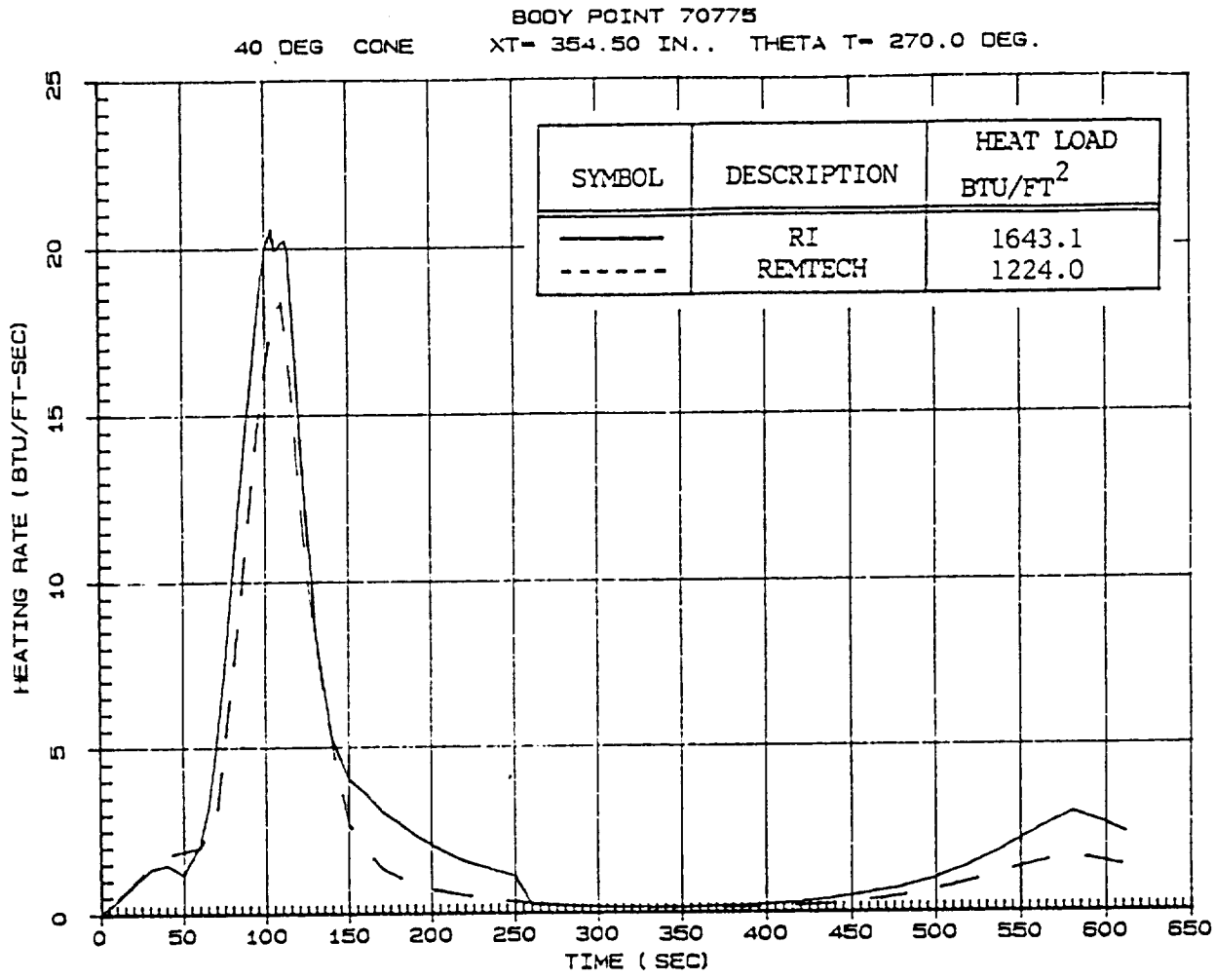


COMMENTS

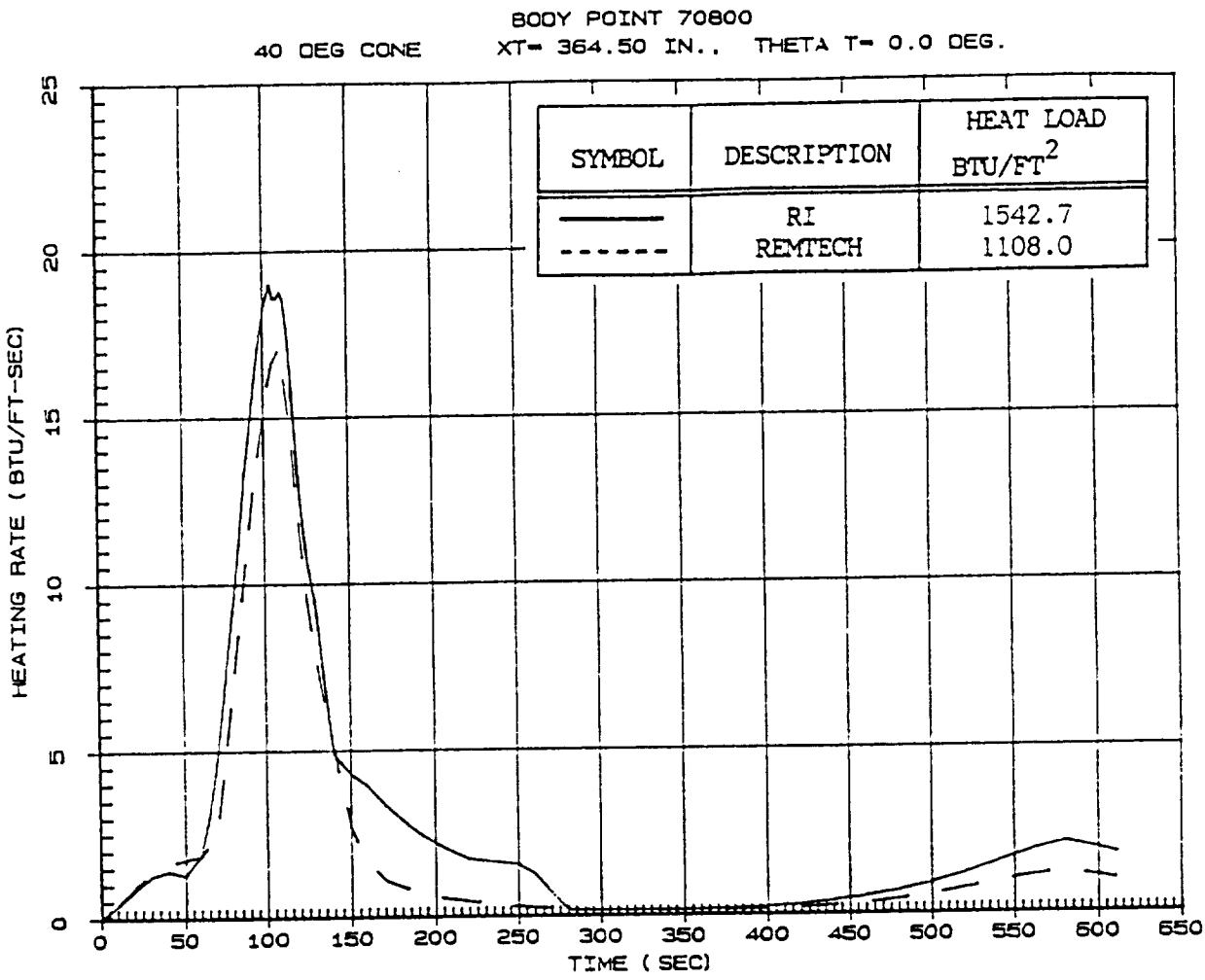
- REMTECH environment includes nose spike interference effects that were based on six sets of flight data measured at one location (X_T = 350, θ_T = 180°)
- Wind tunnel data was laminar/transitional whereas flight data appeared to be transitional/turbulent
- REMTECH environments assumed that the heating amplification factor over the entire 40° cone is constant
- During first stage flight RI has higher amplification factors than REMTECH
- During first stage flight RI has lower undisturbed heating than REMTECH
- Differences between RI and REMTECH environments should not impact current TPS design



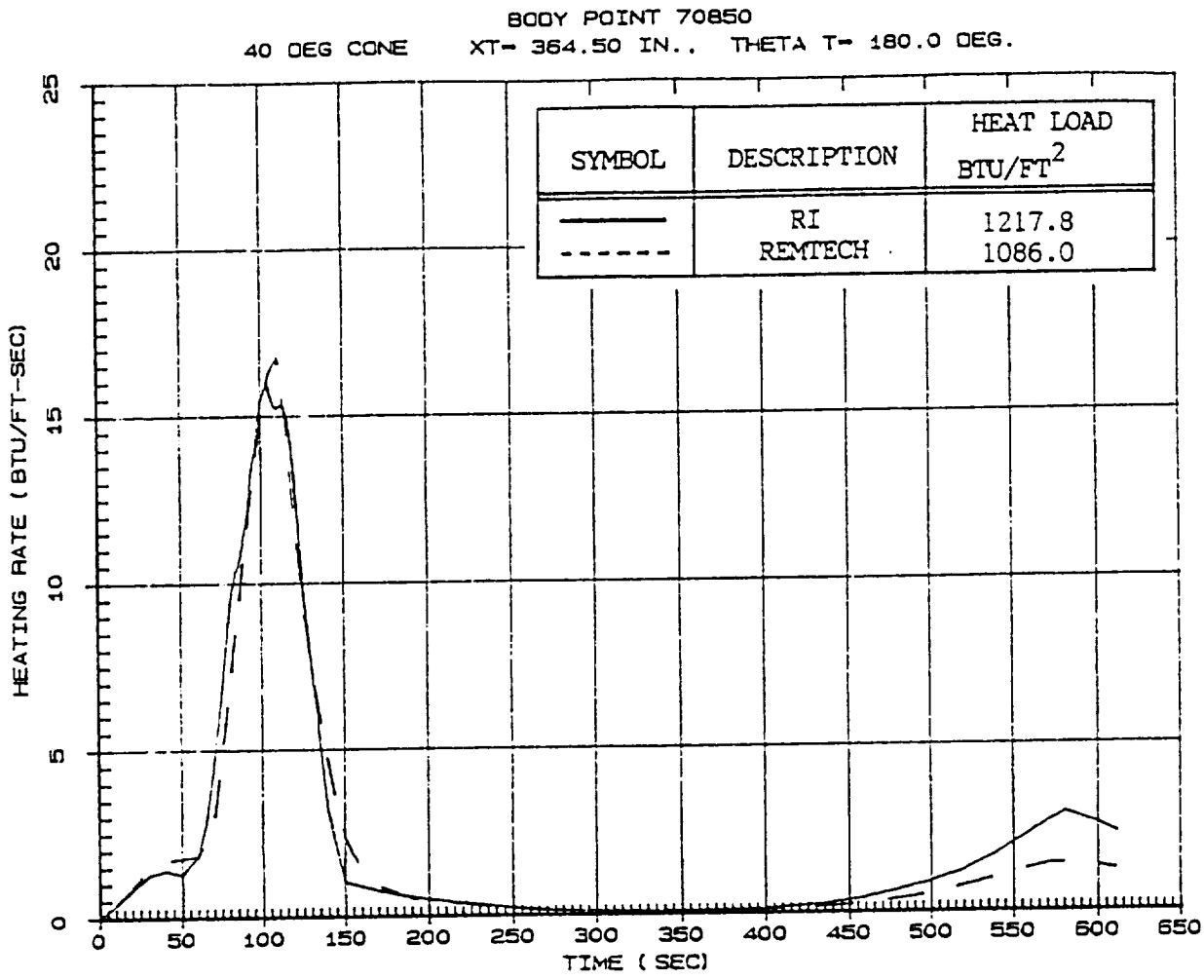
Agreement is acceptable; no TPS impact.



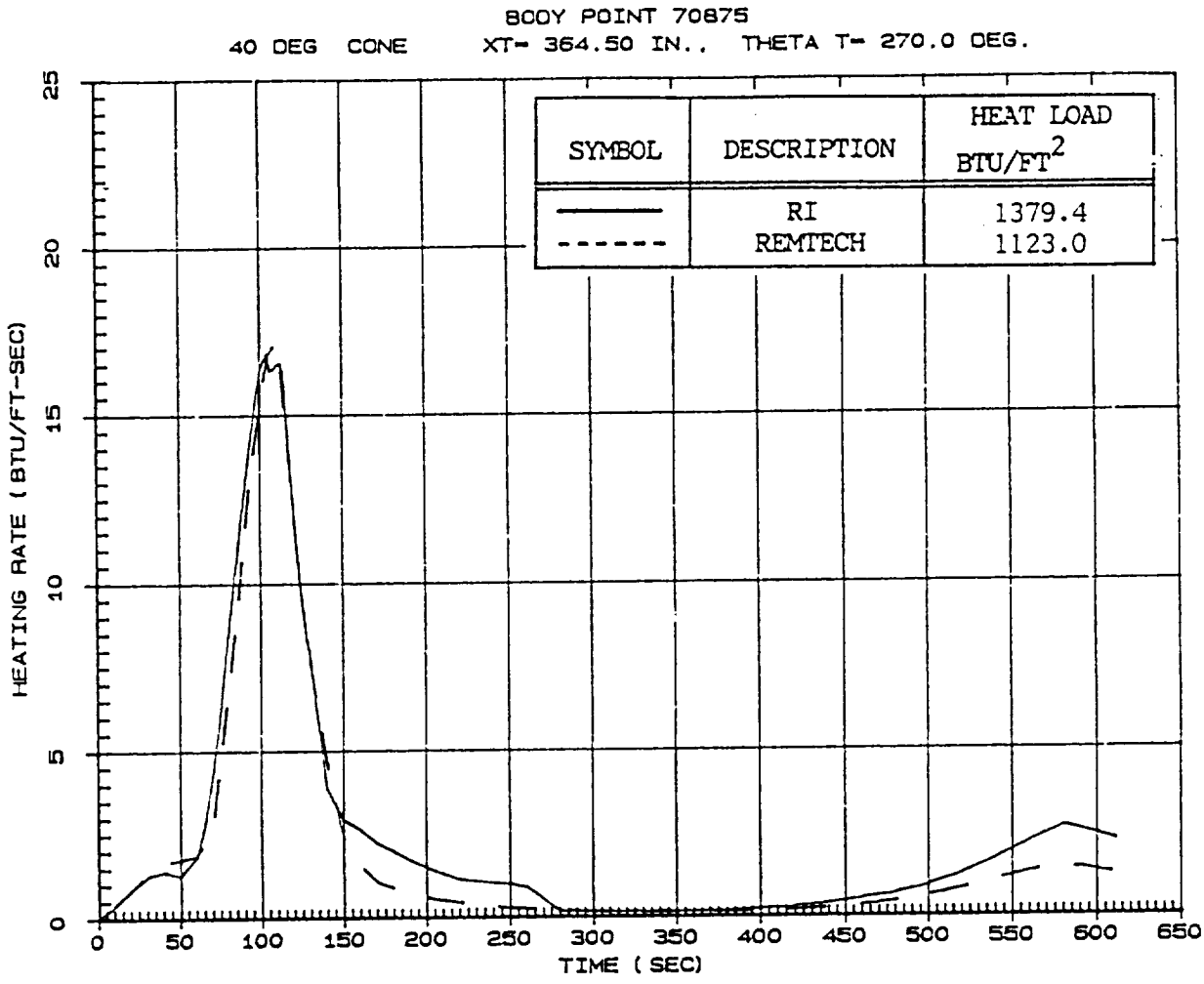
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.

ASCENT DESIGN ENVIRONMENTS FOR THE ET LO_2 TANK ACREAGE BODY POINTS

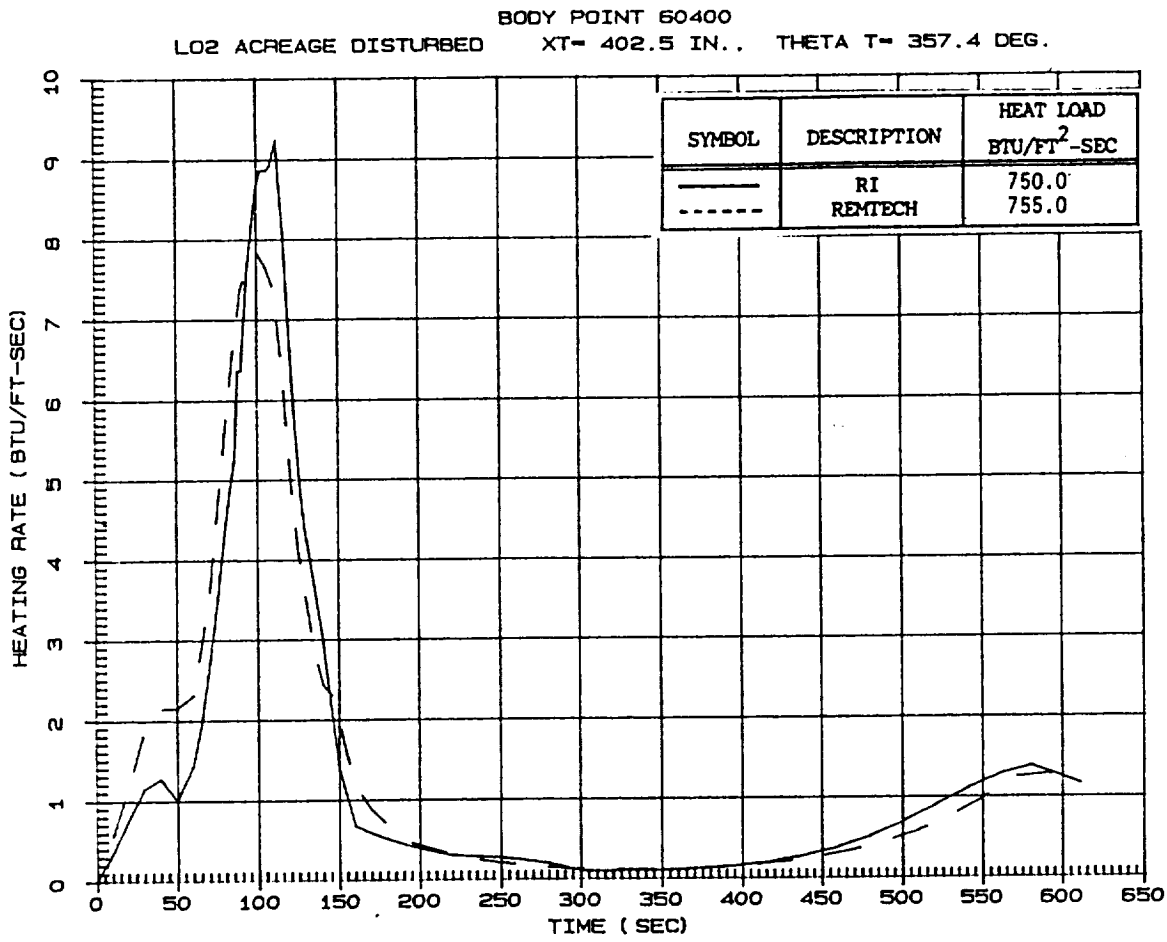


Fig. 1 Comparison of RI and REMTECH Environments for Body Point 60400

Agreement is acceptable; no TPS impact.

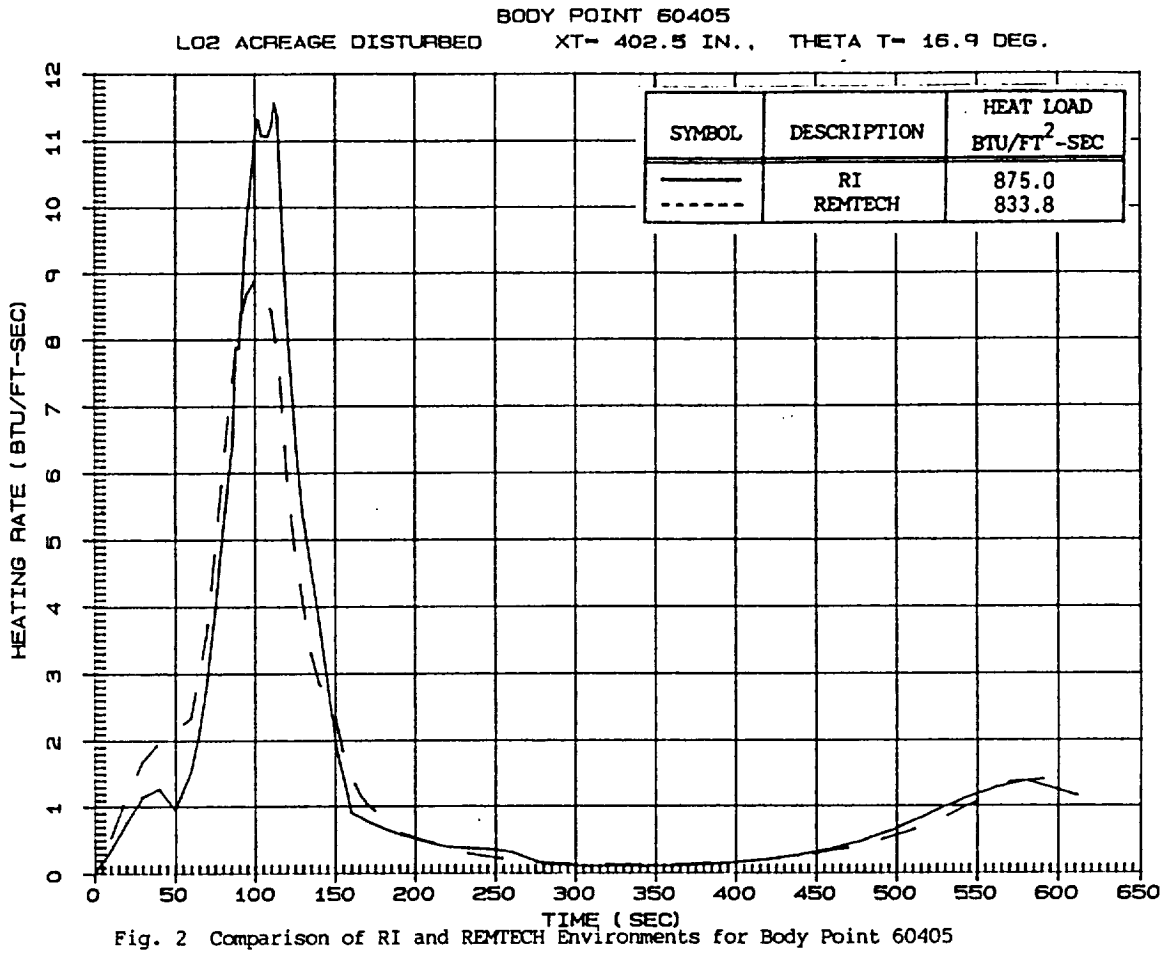


Fig. 2 Comparison of RI and REMTECH Environments for Body Point 60405

- The difference in maximum heating rate between Rockwell and REMTECH generates into a difference of ~ 0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

Agreement is acceptable; no TPS impact.

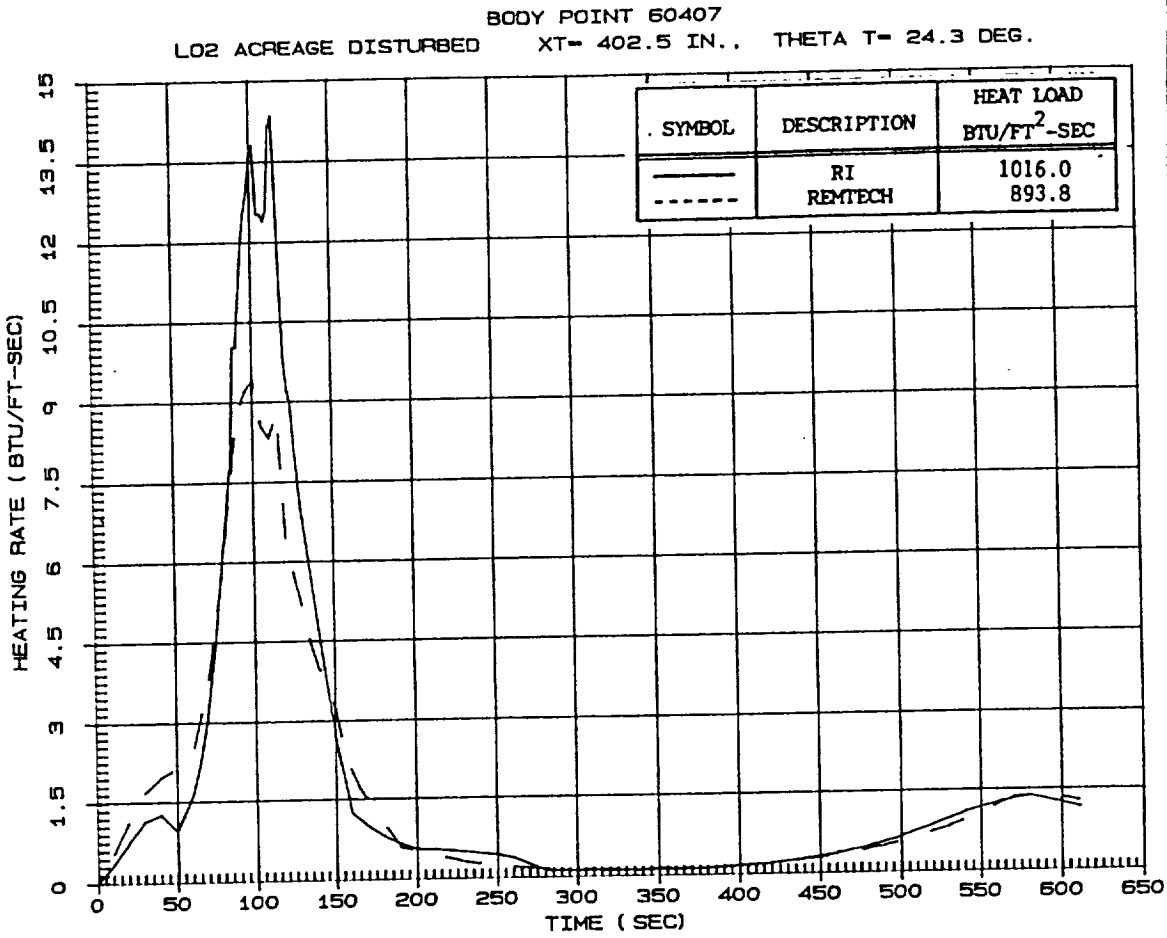


Fig. 3 Comparison on RI and REMTECH Environments for Body Point 60407

- The difference in maximum heating rate between Rockwell and REMTECH generates into a difference of ~ 0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

Agreement is acceptable; no TPS impact.

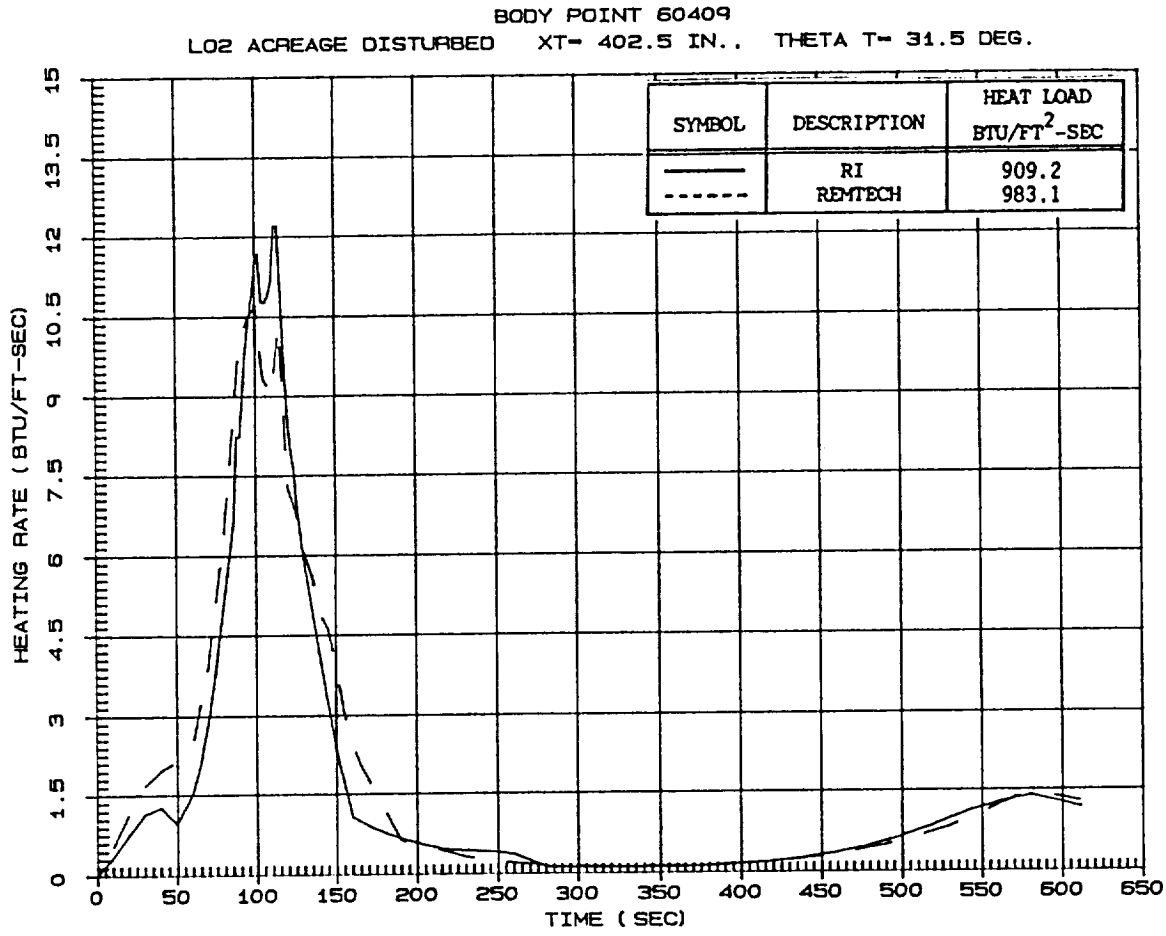


Fig. 4 Comparison of RI and REMTECH Environments for Body Point 60409

Agreement is acceptable; no TPS impact.

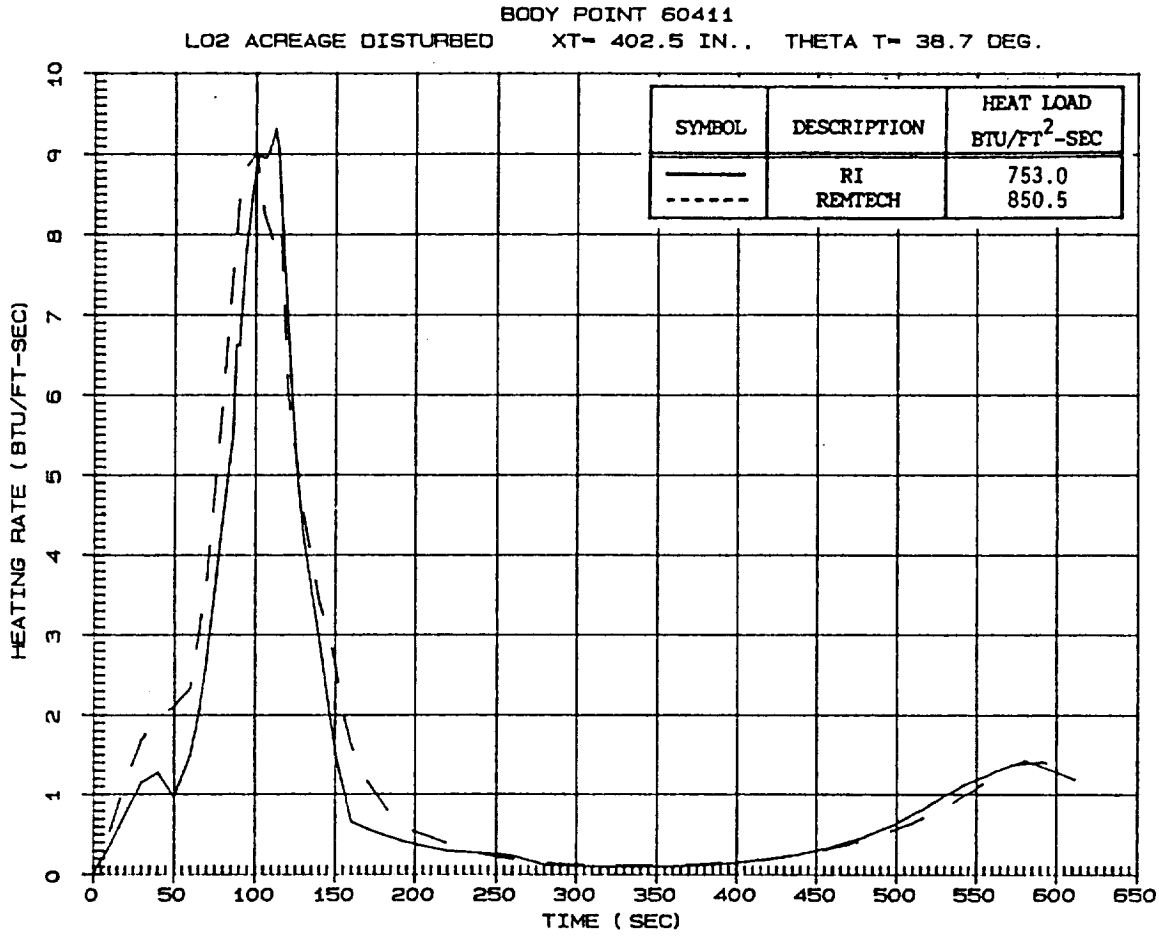


Fig. 5 Comparison of RI and REMTECH for Body Point 60411

Agreement is acceptable; no TPS impact.

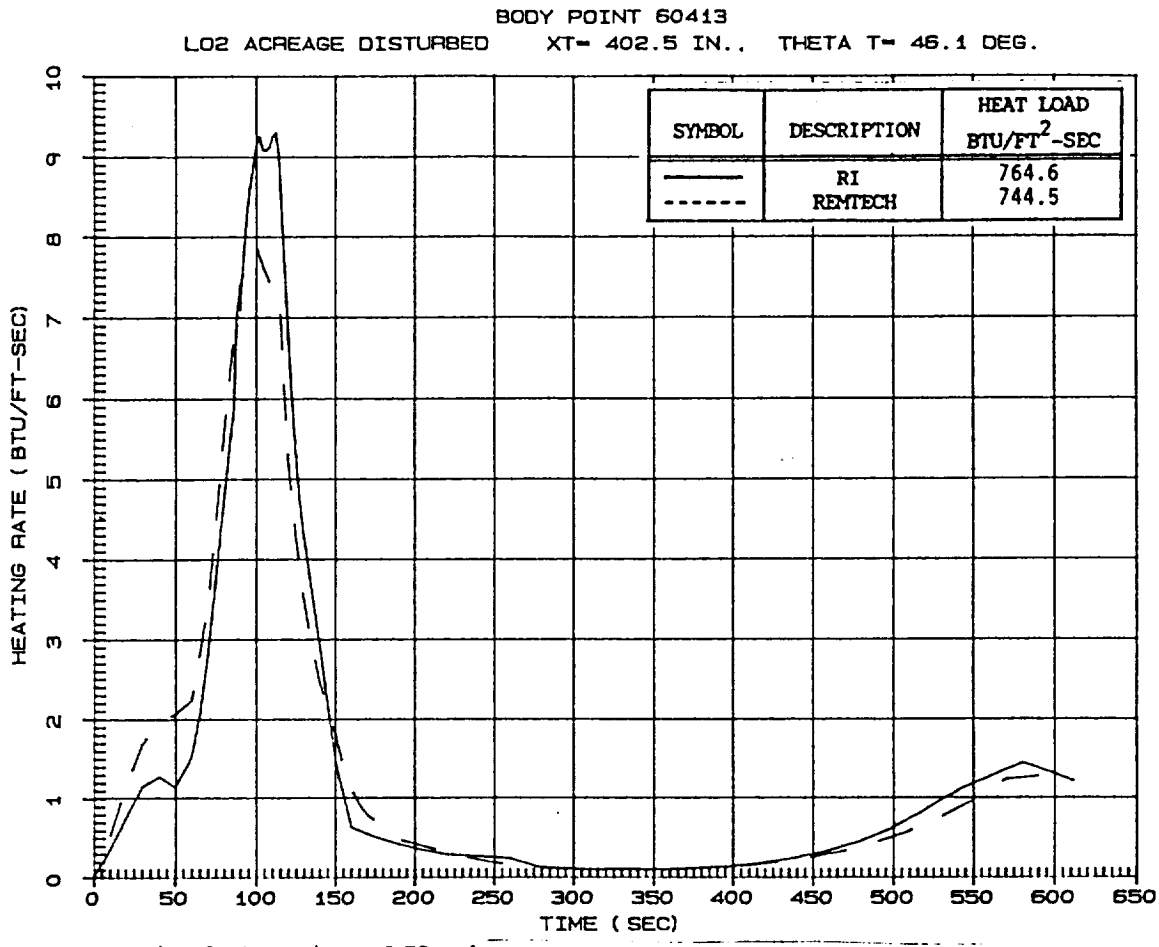


Fig. 6 Comparison of RI and REMTECH Environments for Body Point 60413

- The difference in maximum heating rate between Rockwell and REMTECH generates into a difference of $\leq$ 0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

Agreement is acceptable; no TPS impact.

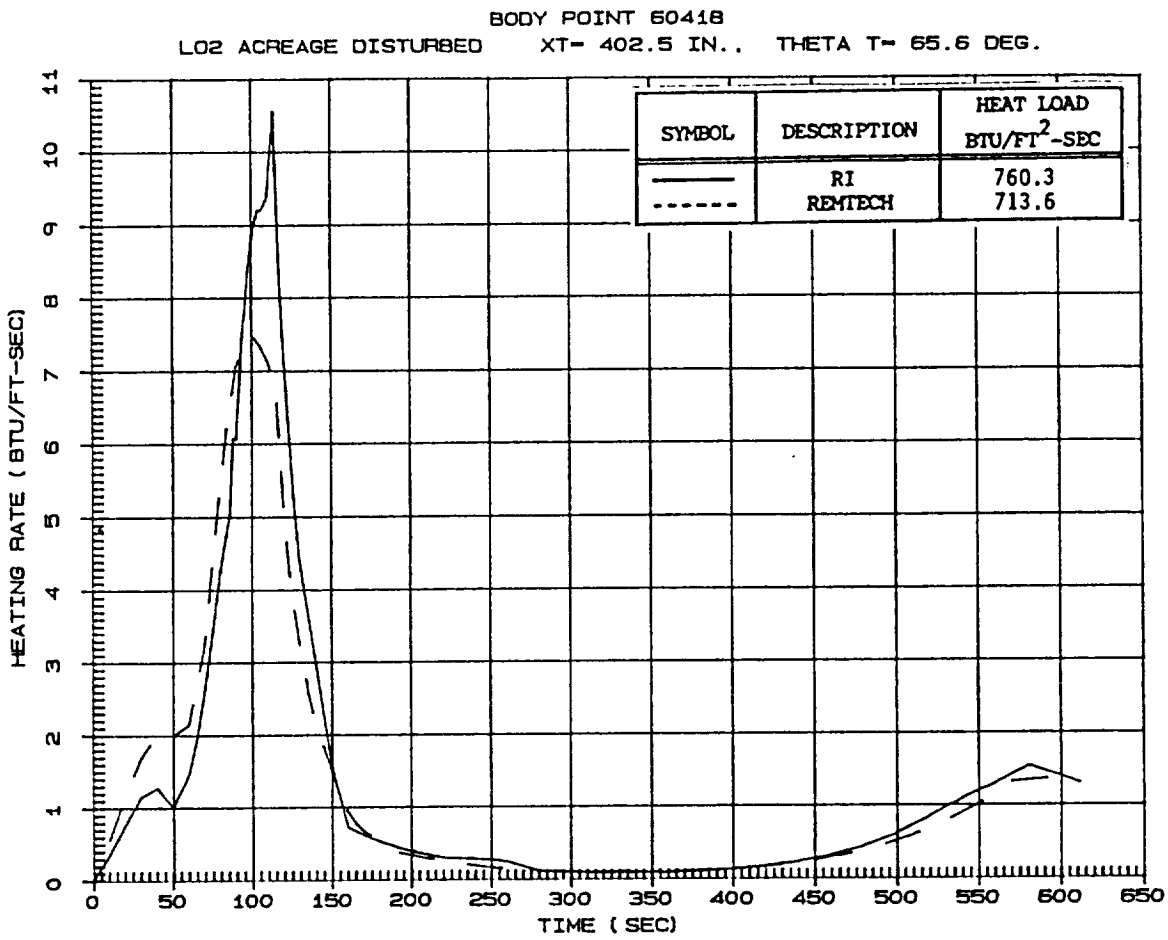


Fig. 7 Comparison of RI and REMTECH Environments for Body Point 60418

- The difference in maximum heating rate between Rockwell and REMTECH generates into a difference of ~ 0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

Agreement is acceptable; no TPS impact.

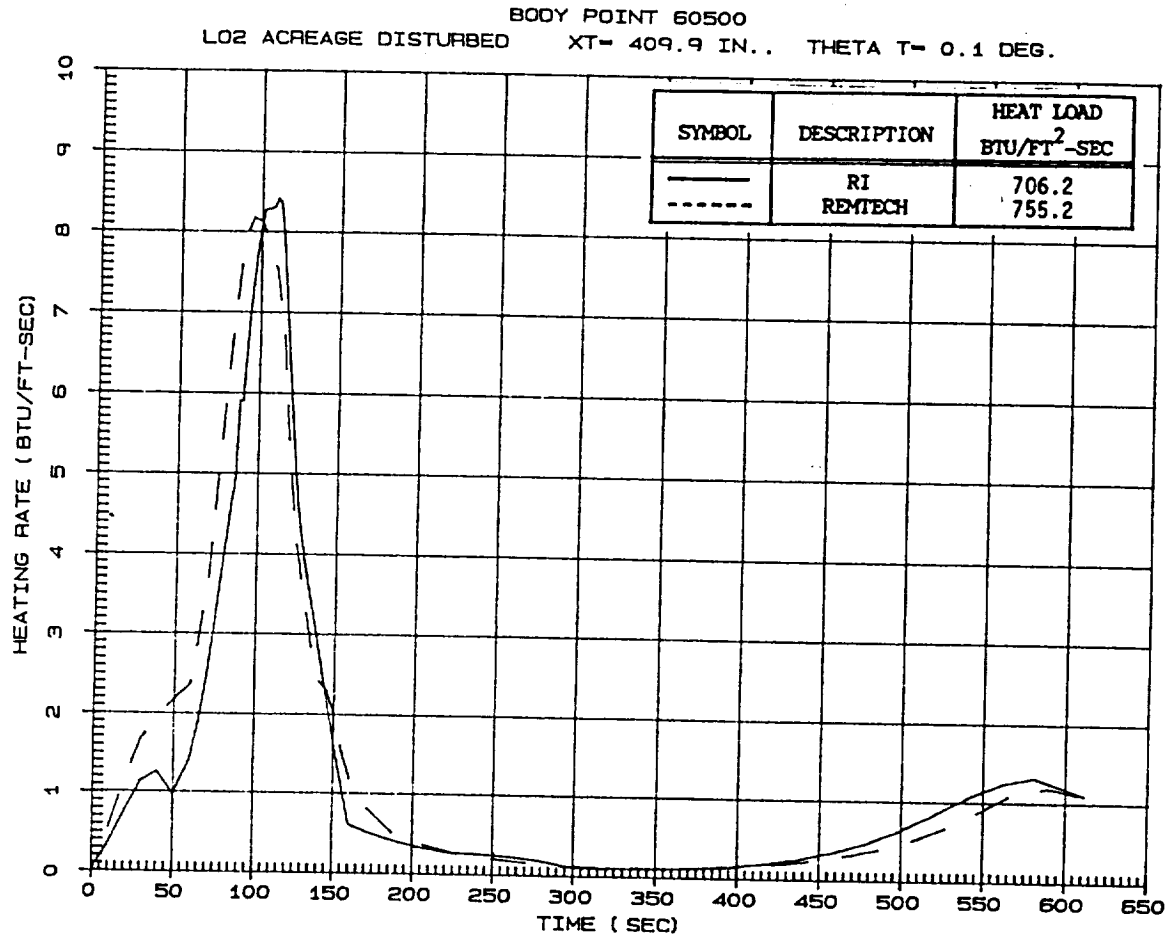


Fig. 8 Comparison of RI and REMTECH Environments for Body Point 60500

Agreement is acceptable; no TPS impact.

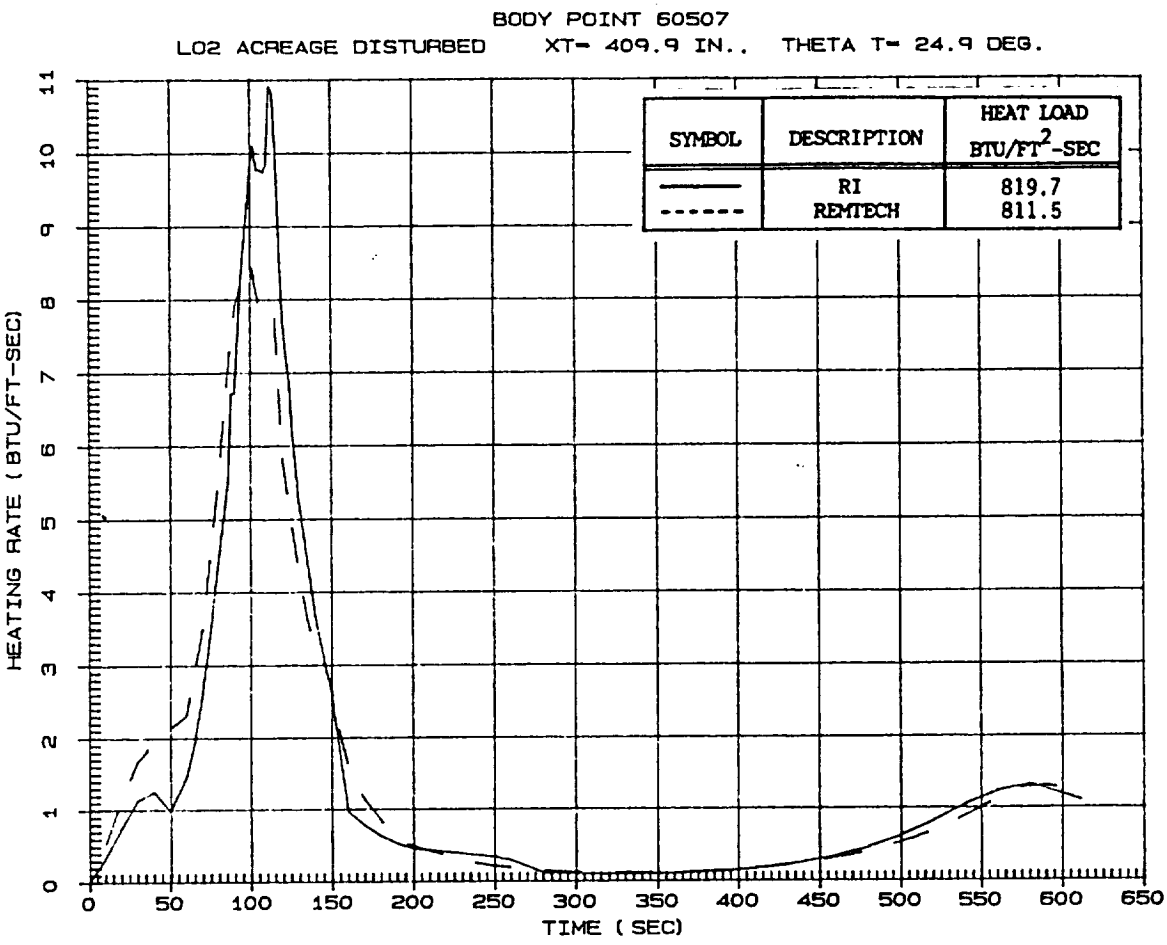


Fig. 9 Comparison of RI and REMTECH environments for Body Point 60507

- The difference in max heating rate between Rockwell and REMTECH generates ~ 0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

Agreement is acceptable; no TPS impact.

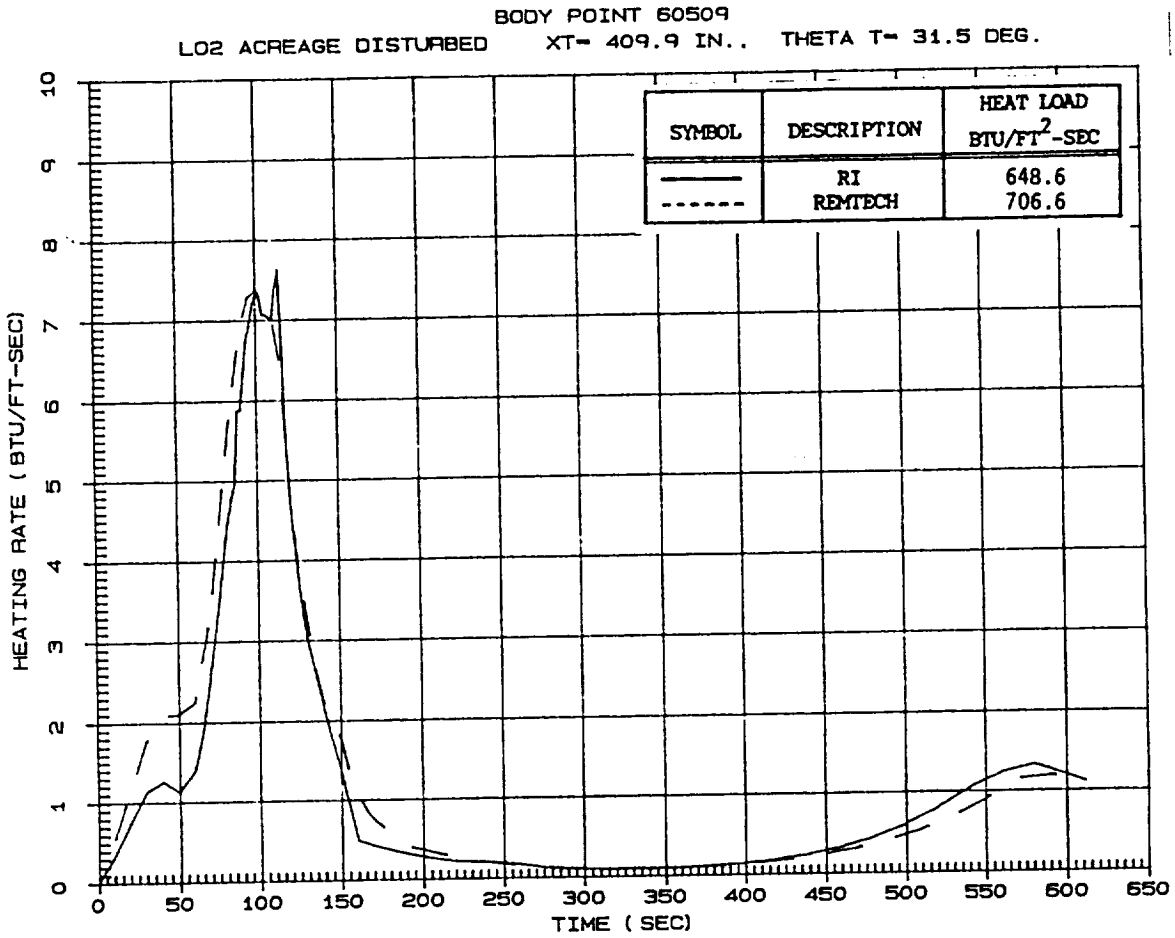


Fig. 10 Comparison of RI and REMTECH Environments for Body Point 60509

Agreement is acceptable; no TPS impact.

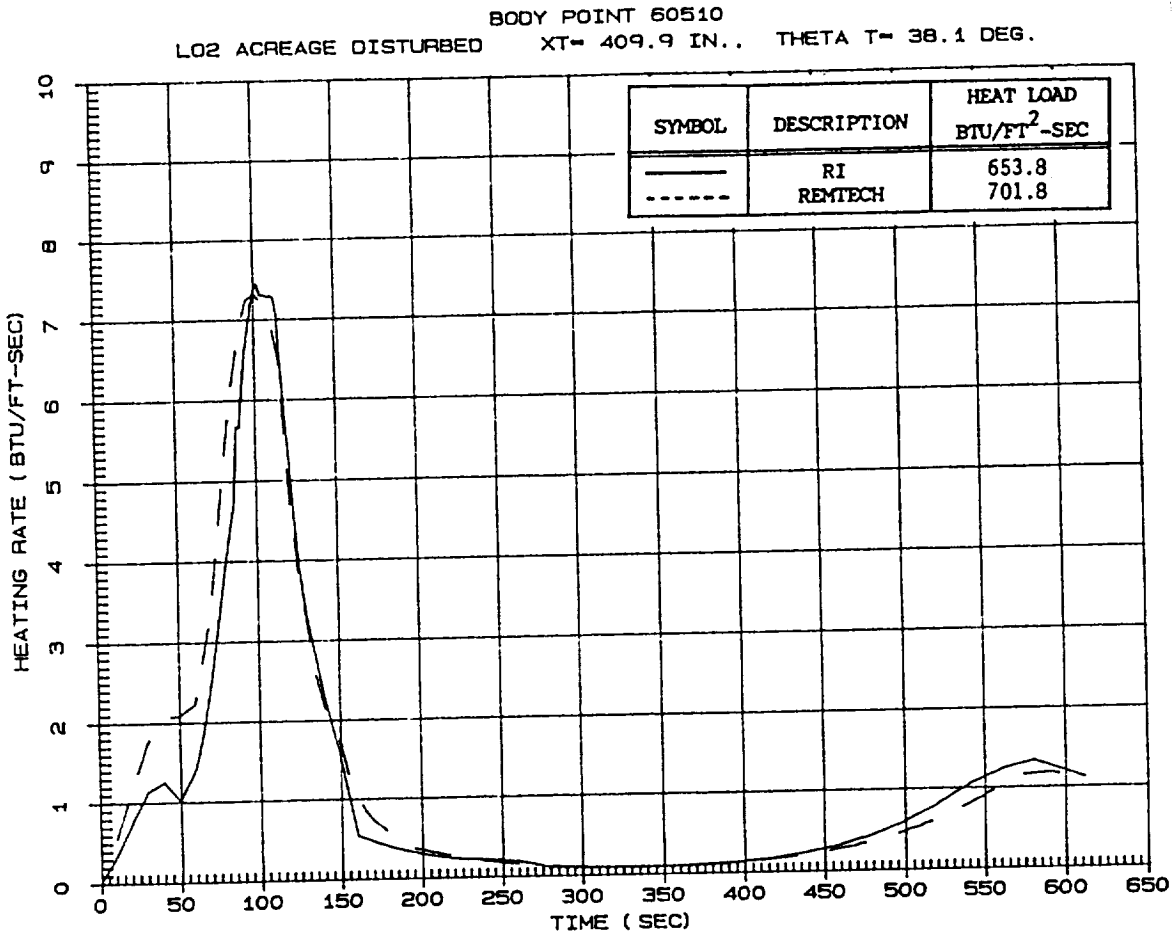


Fig. 11 Comparison of RI and REMTECH Environments for Body Point 60510

Agreement is acceptable; no TPS impact.

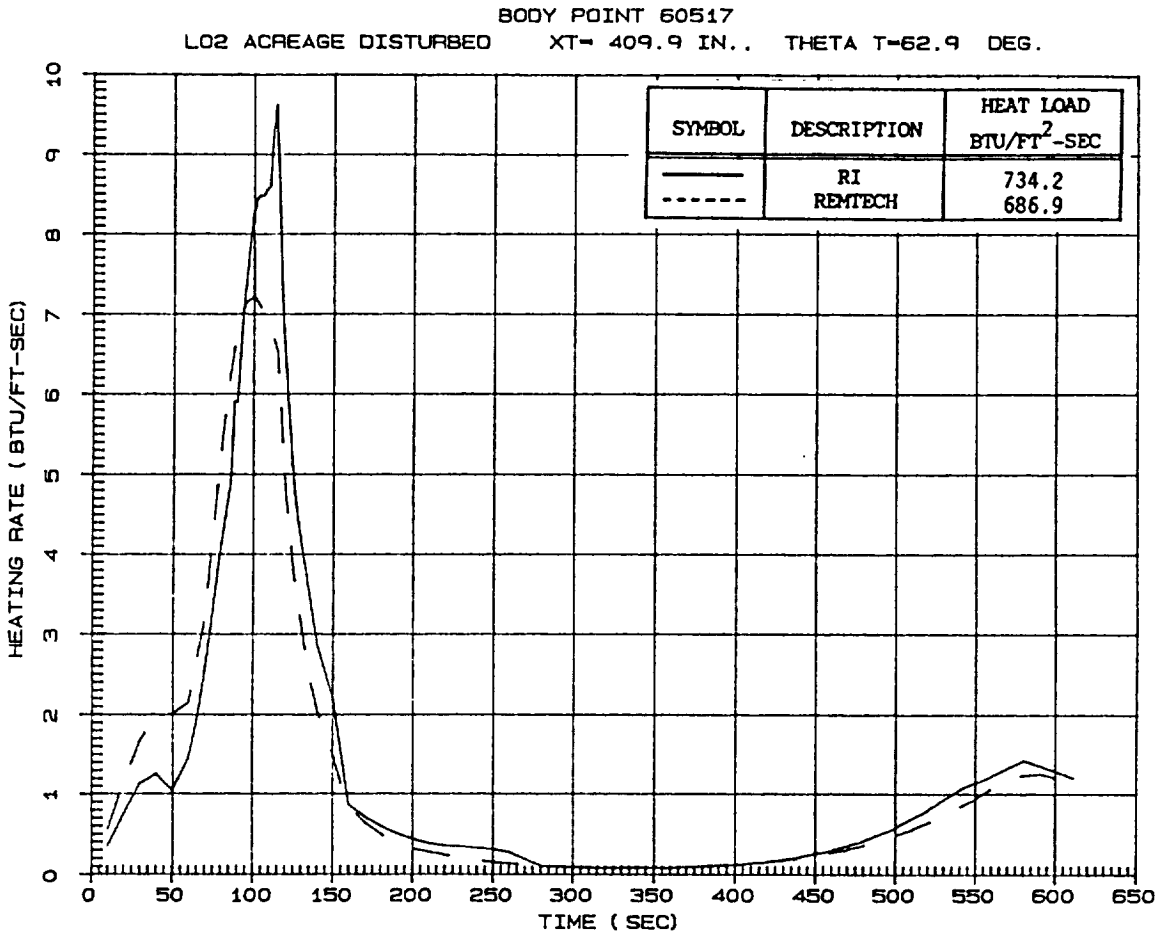


Fig. 12 Comparison of RI and REMTECH Environments for Body Point 60517

- The difference in max heating rate between Rockwell and REMTECH generates $<$ 0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

Agreement is acceptable; no TPS impact.

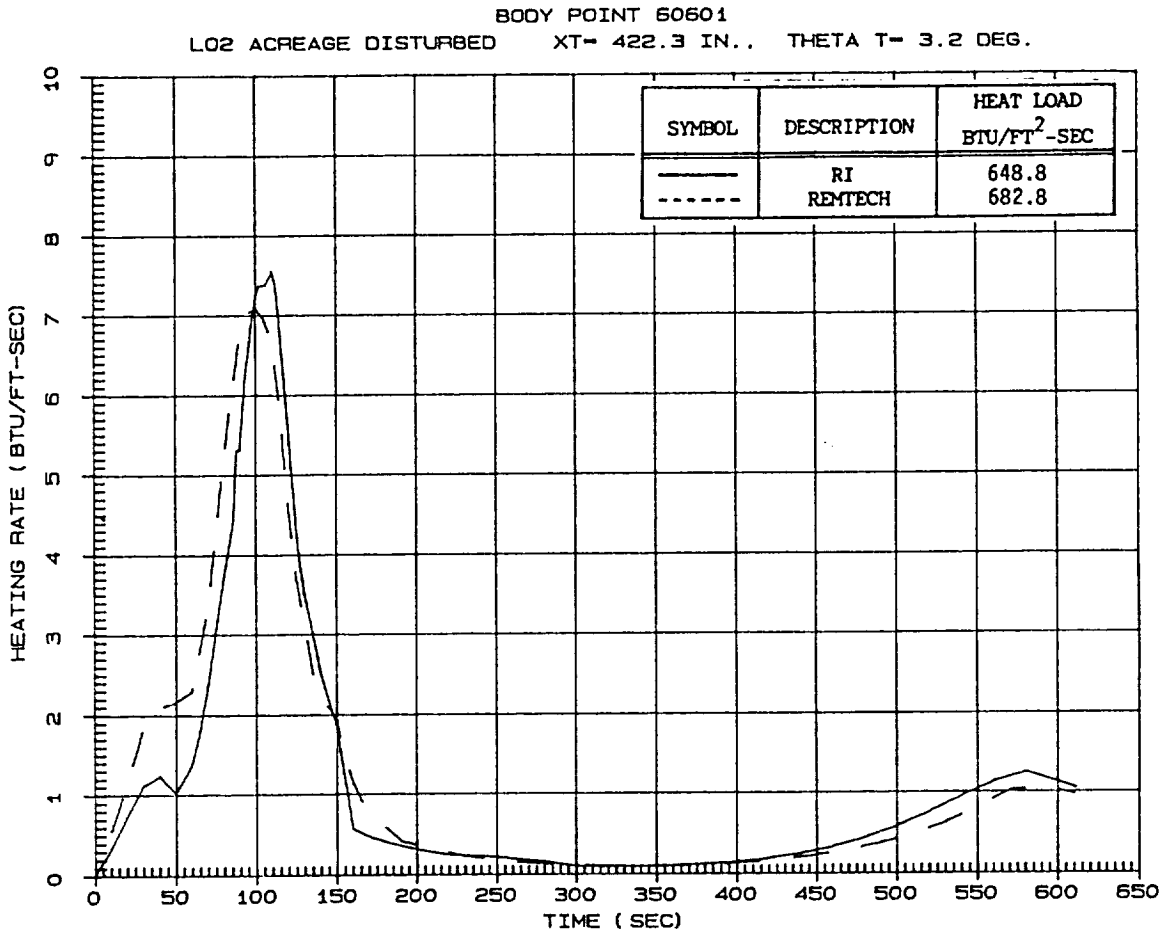


Fig. 13 Comparison of RI and REMTECH Environments for Body Point 60601

Agreement is acceptable; no TPS impact.

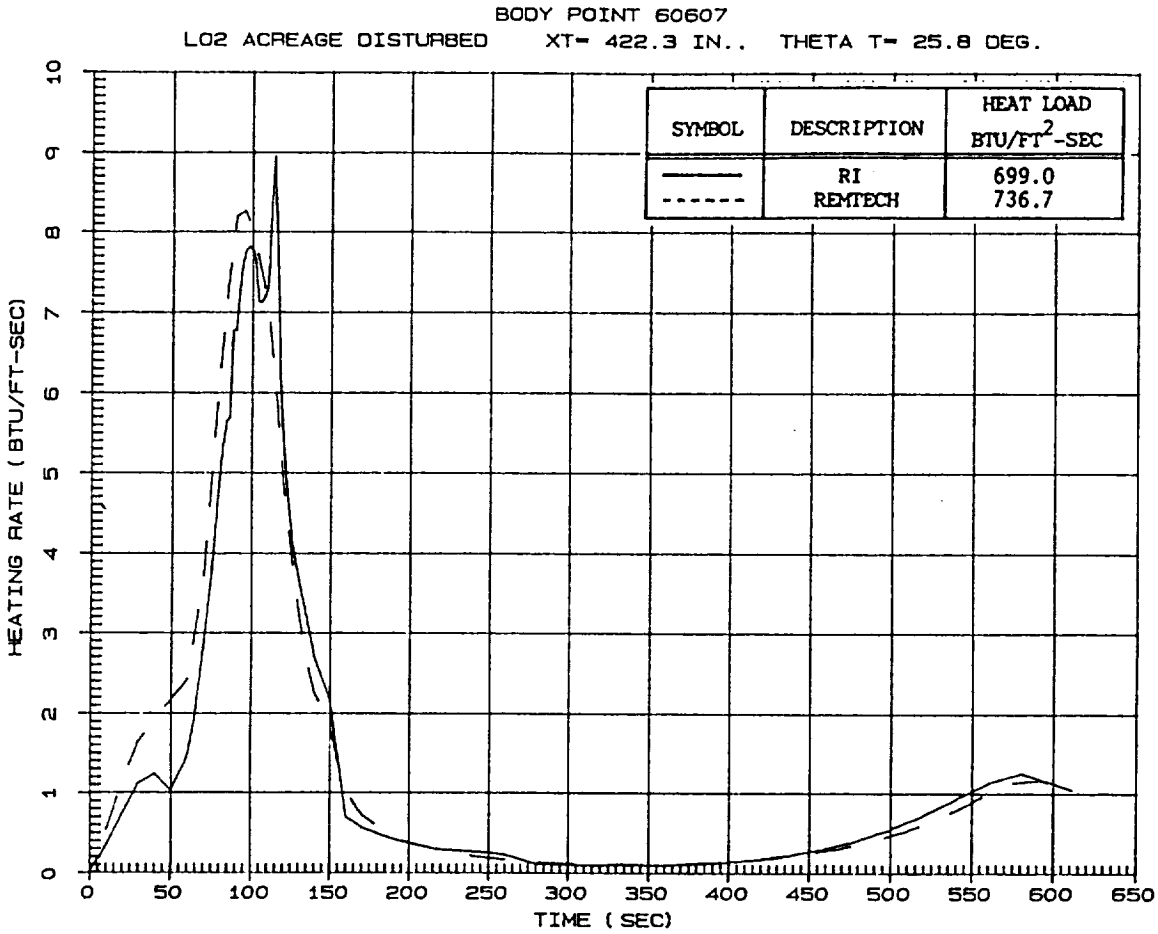


Fig. 14 Comparison of RI and REMTECH Environments for Body Point 60607

Agreement is acceptable; no TPS impact.

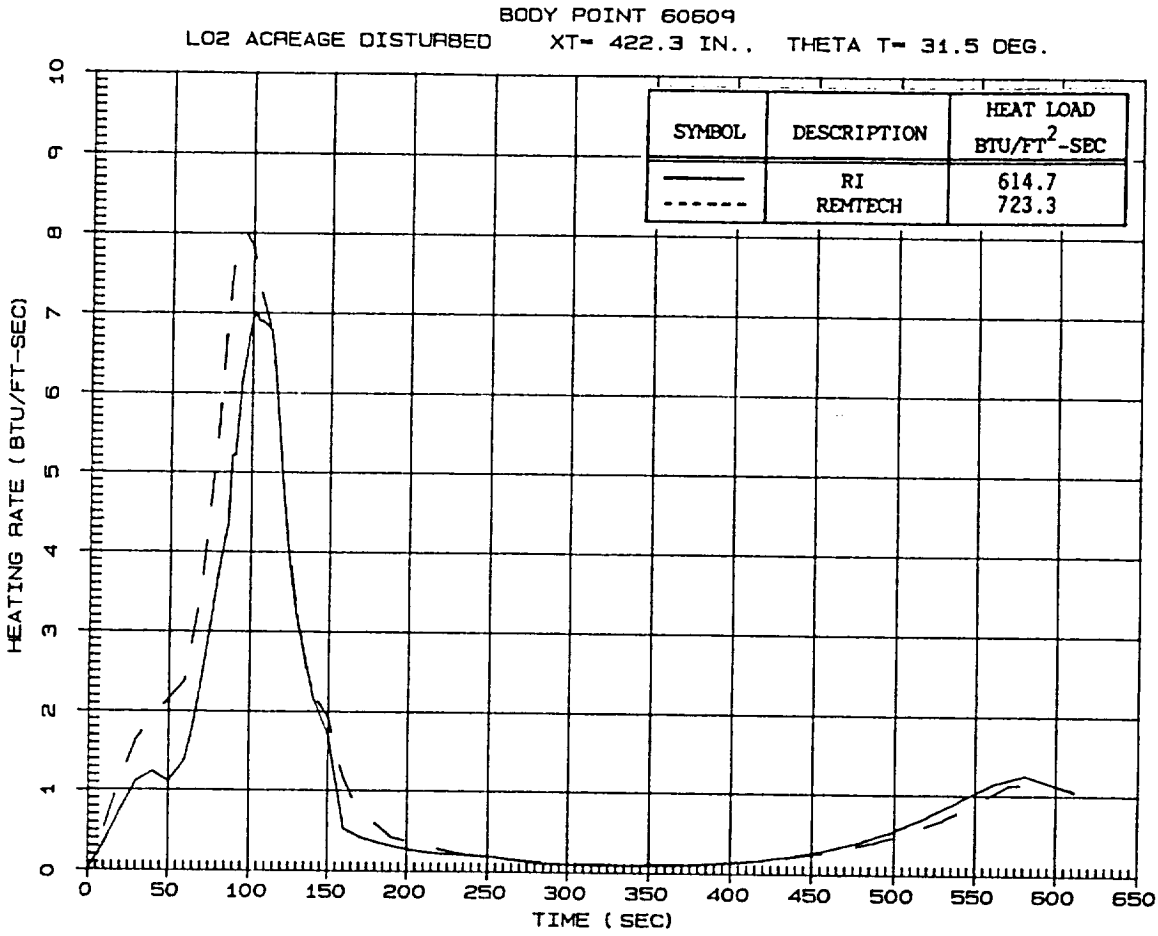


Fig. 15 Comparison of RI and REMTECH Environments for Body Point 60609

Agreement is acceptable; no TPS impact.

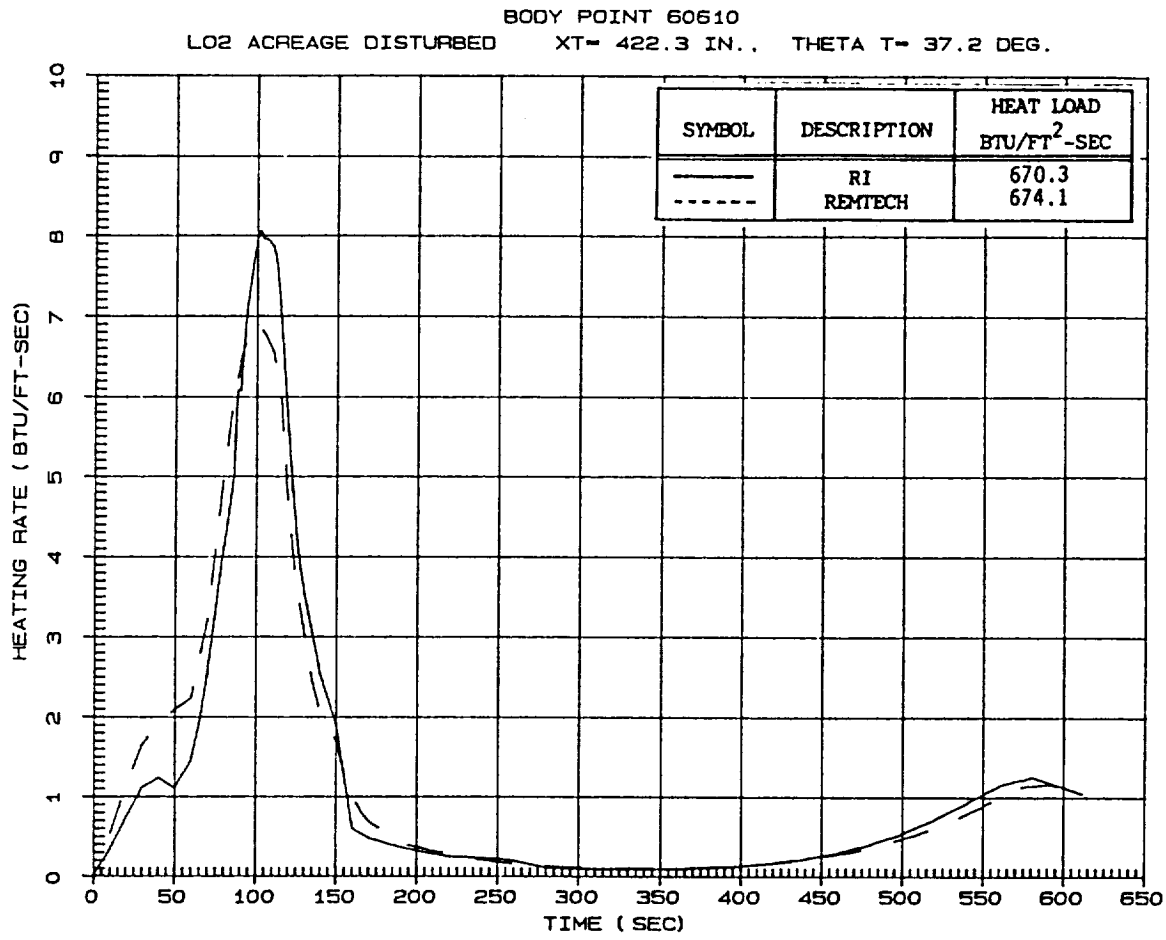


Fig. 16 Comparison of RI and REMTECH Environments for Body Point 60610

Agreement is acceptable; no TPS impact.

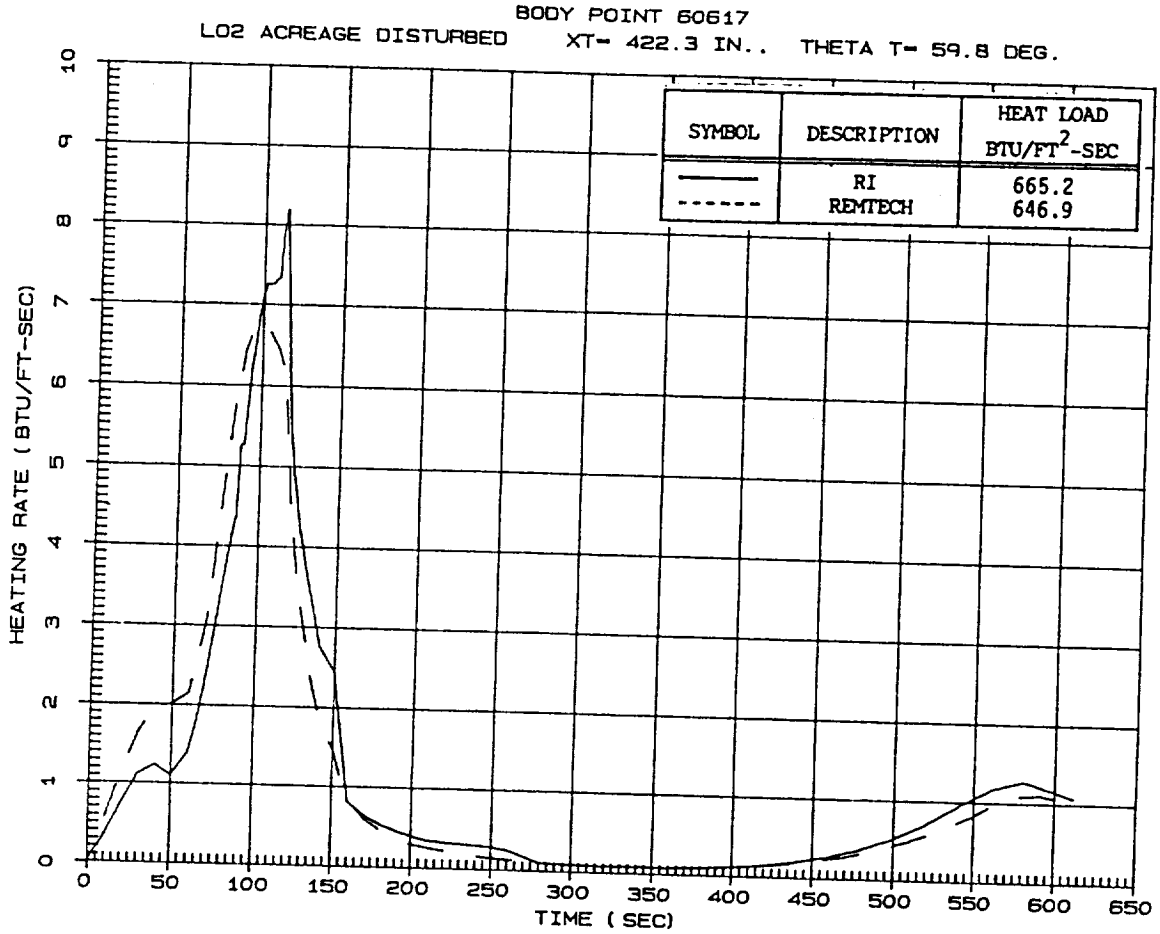
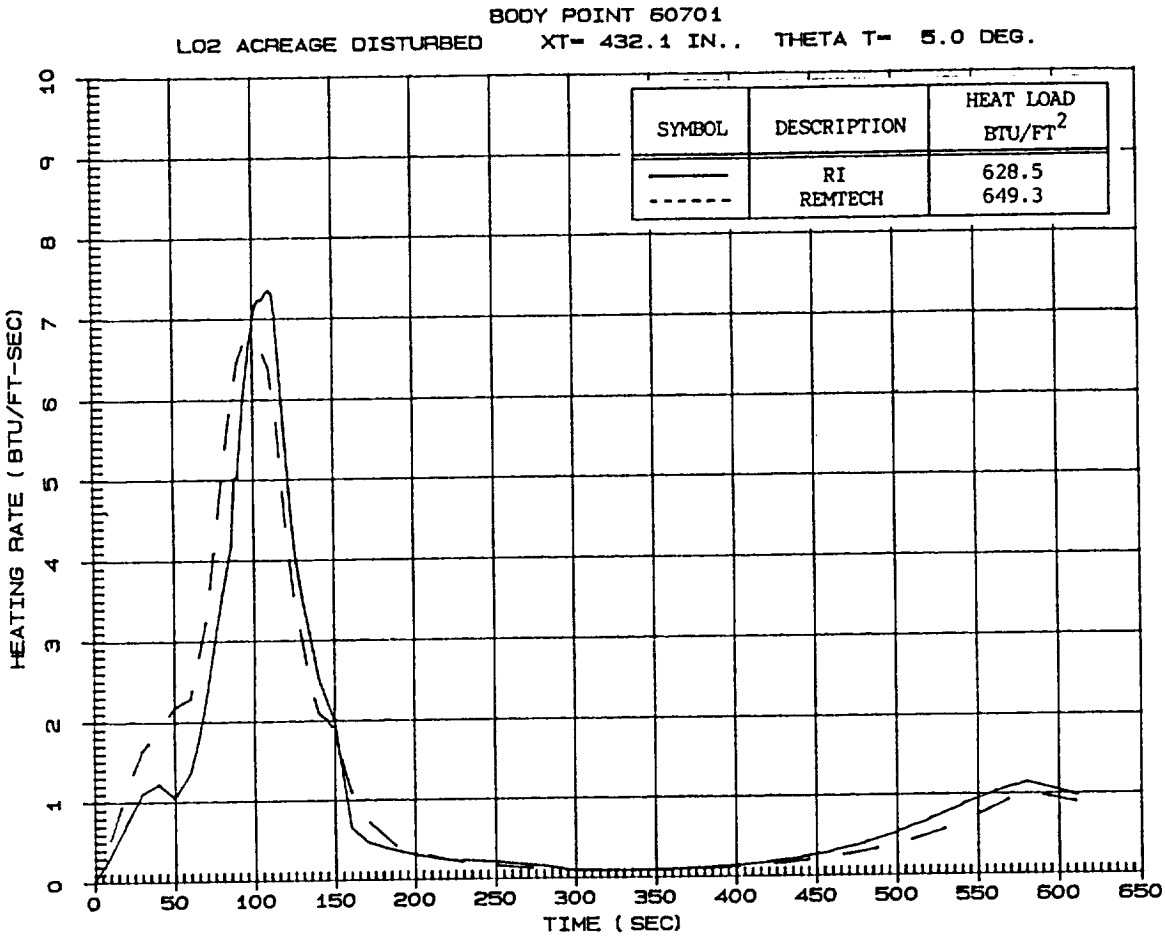
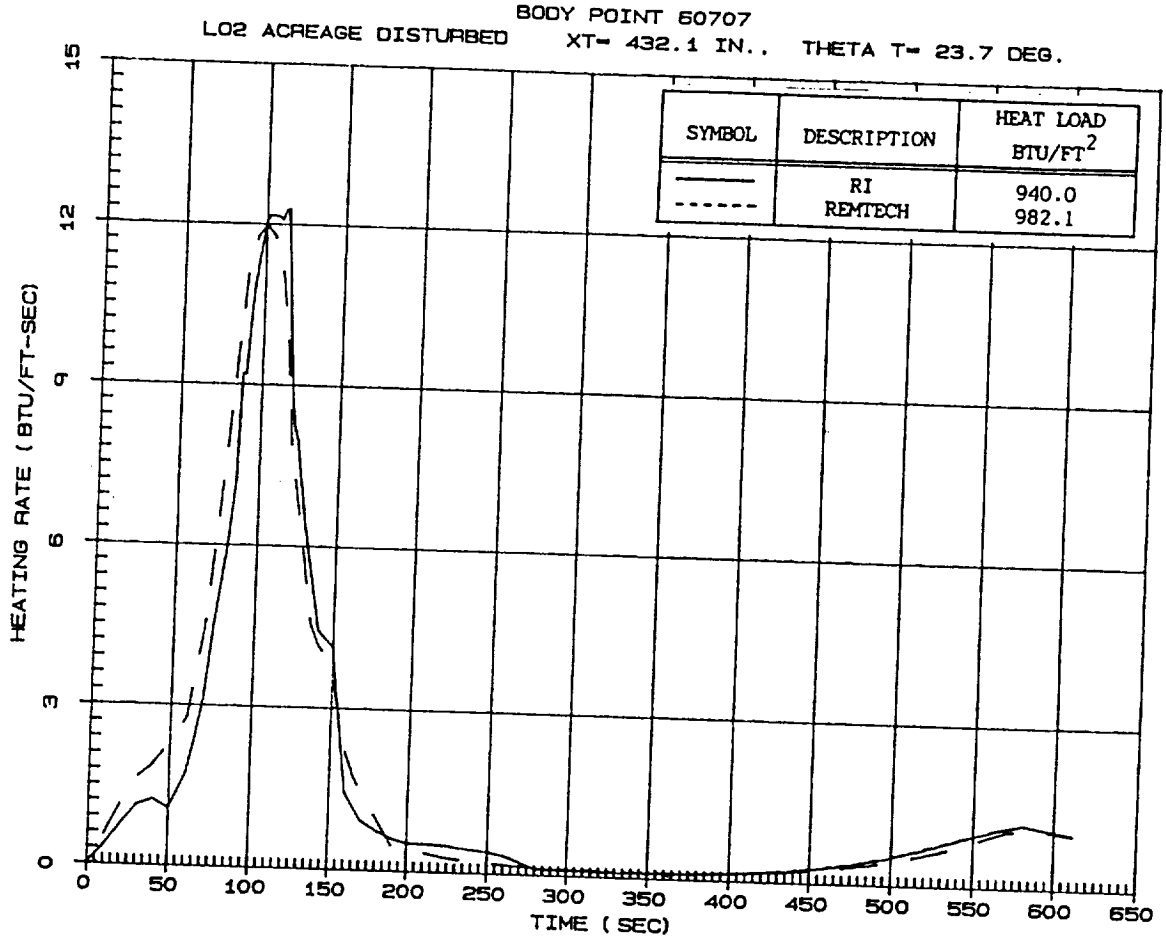


Fig. 17 Comparison of RI and REMTECH Environments for Body Point 60617

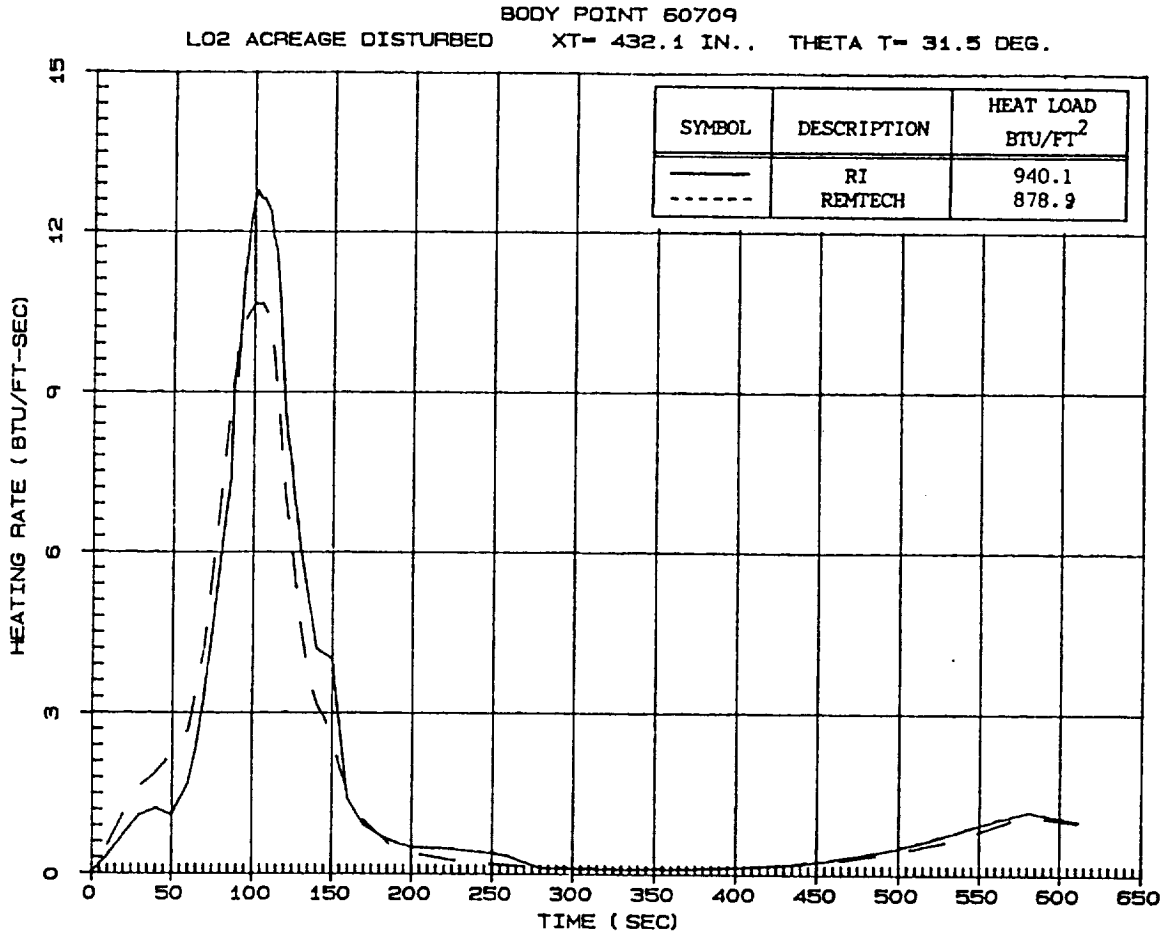
Agreement is acceptable; no TPS impact.



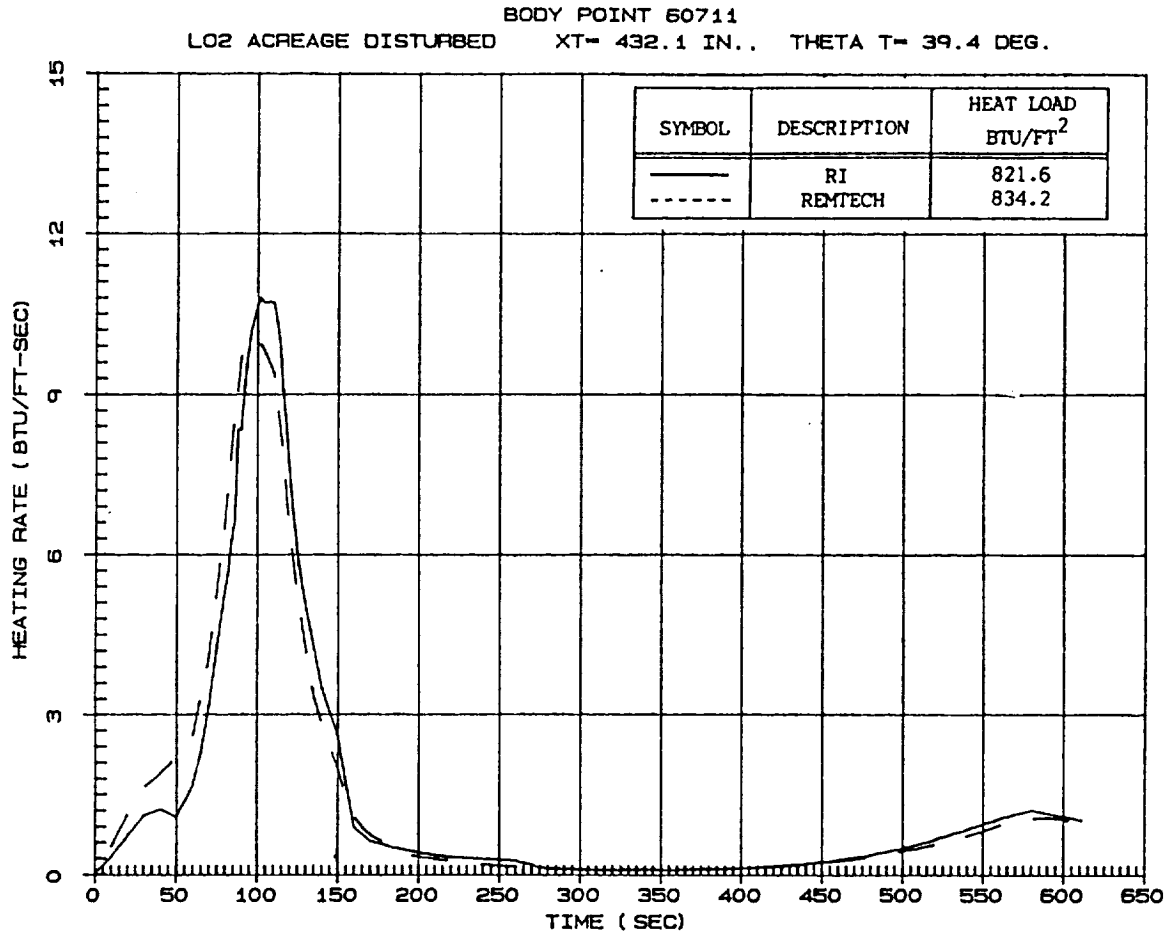
Agreement is acceptable; no TPS impact.



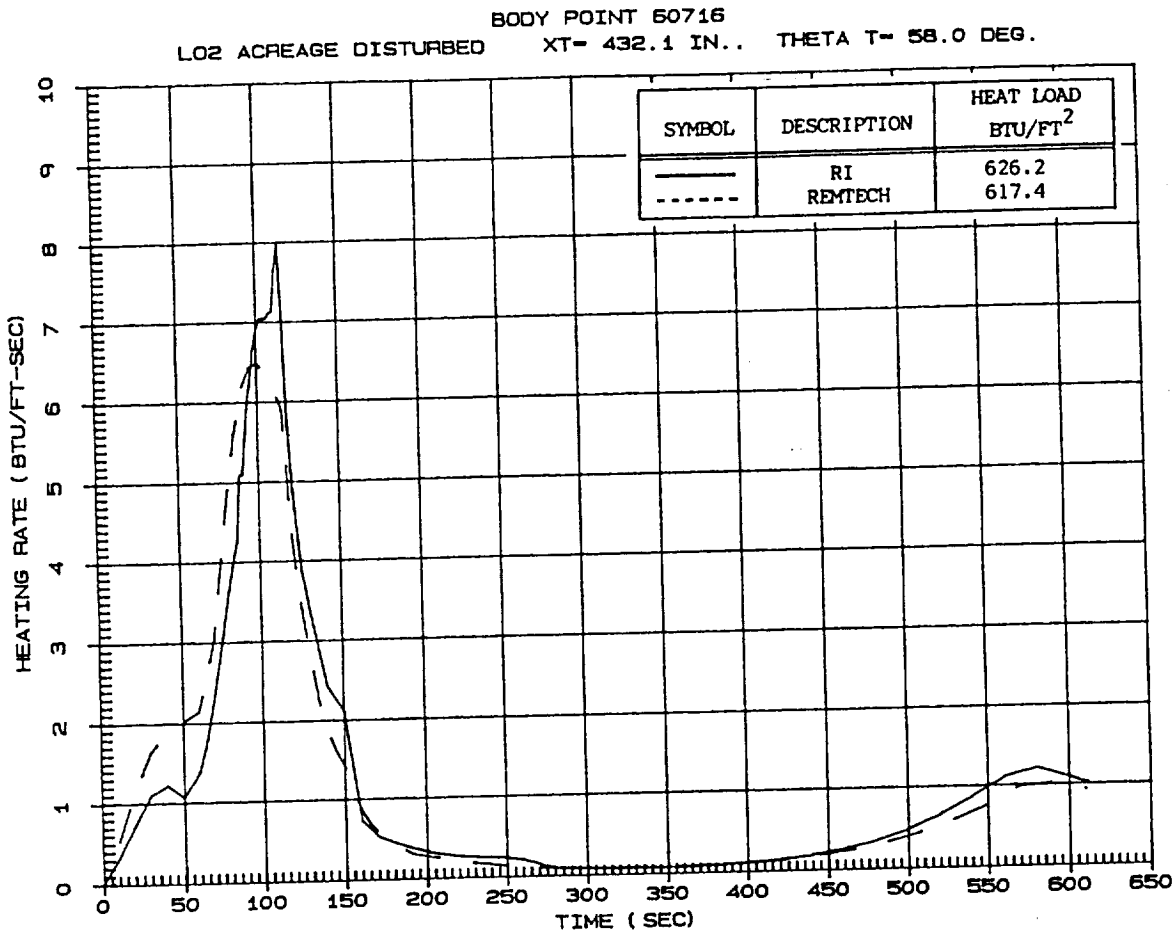
Agreement is acceptable; no TPS impact.



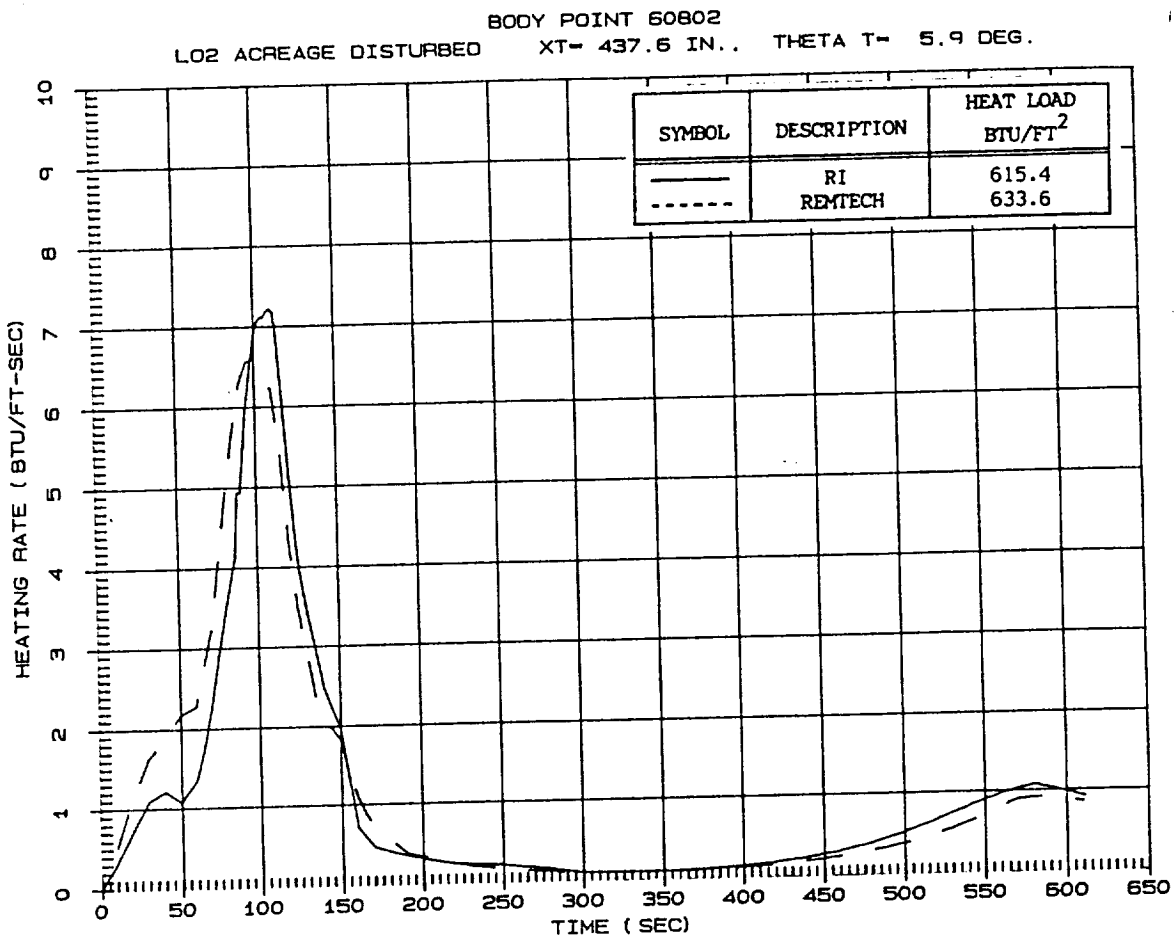
Agreement is acceptable; no TPS impact.



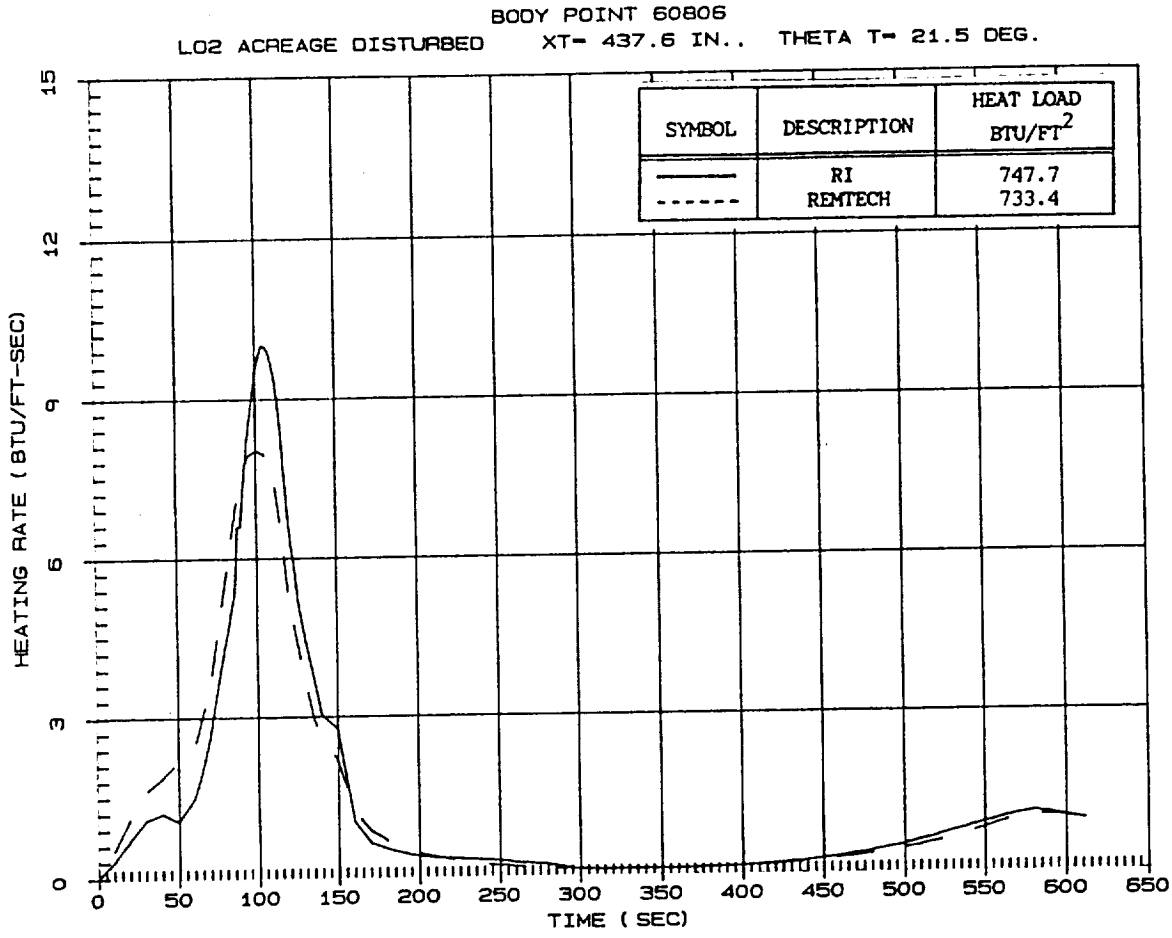
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



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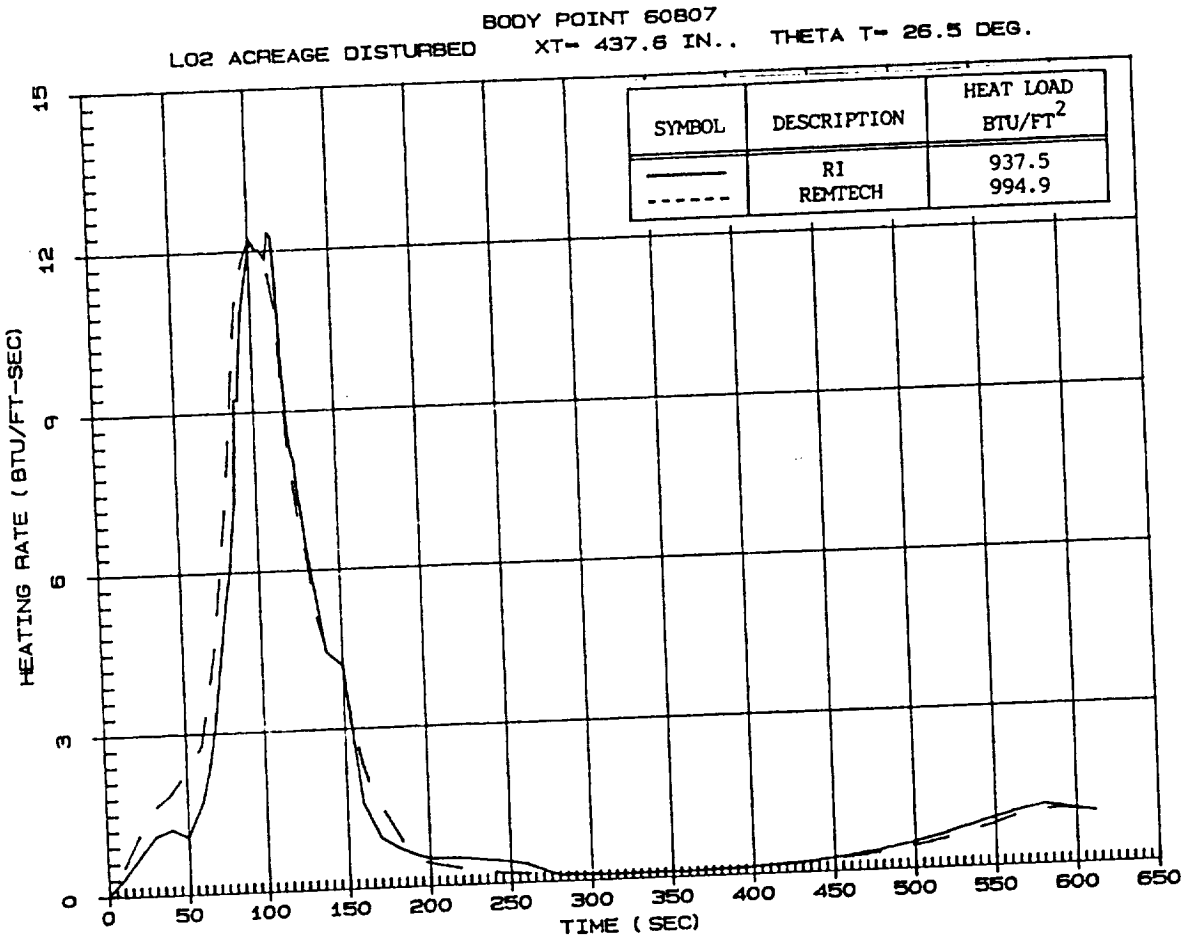

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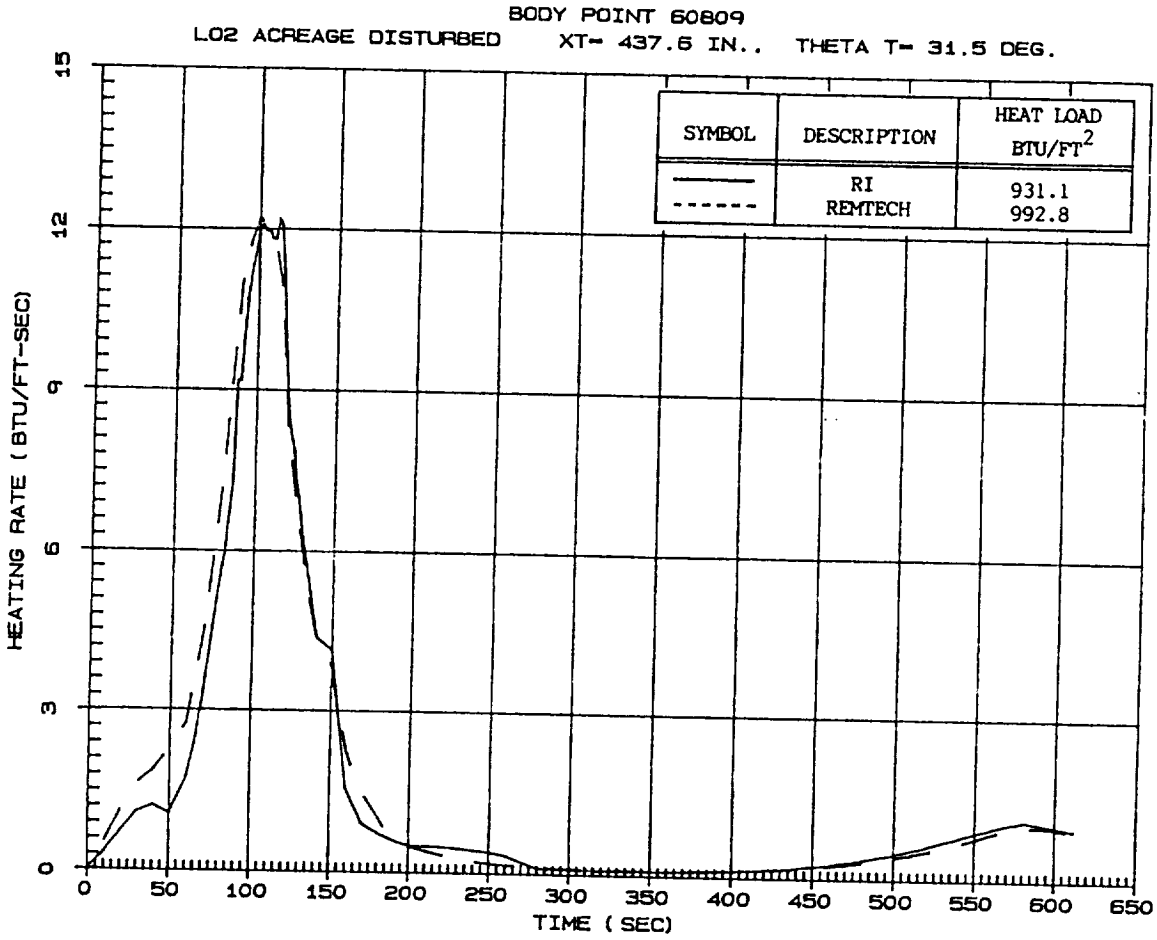

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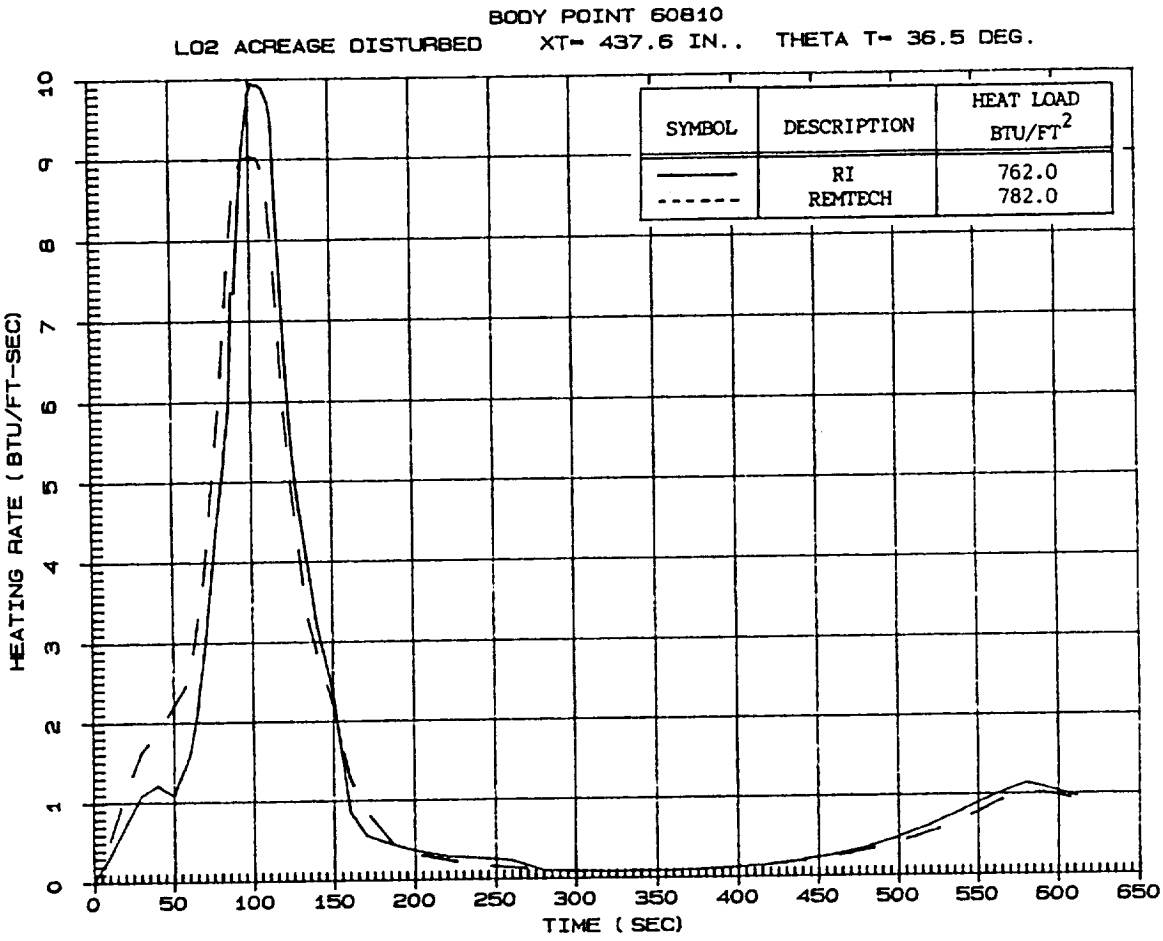

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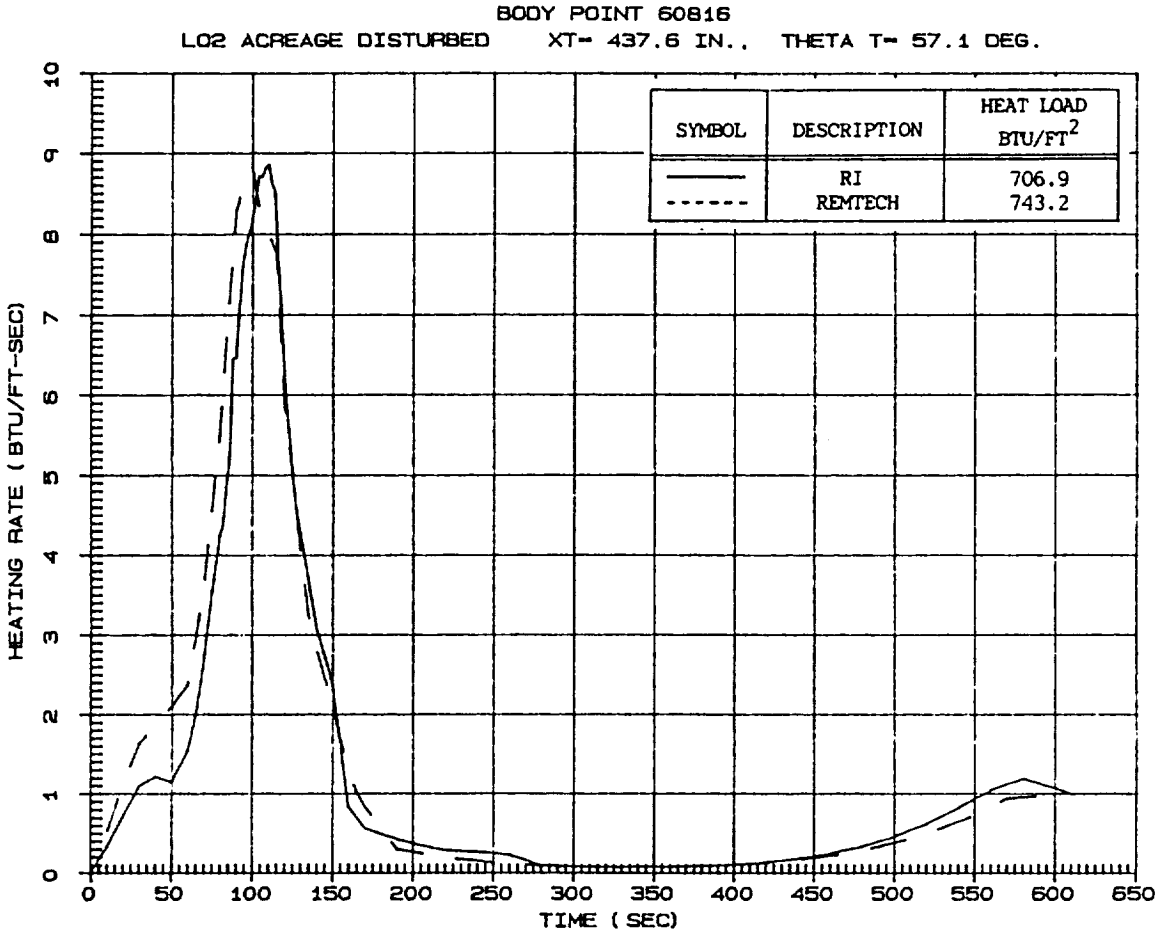

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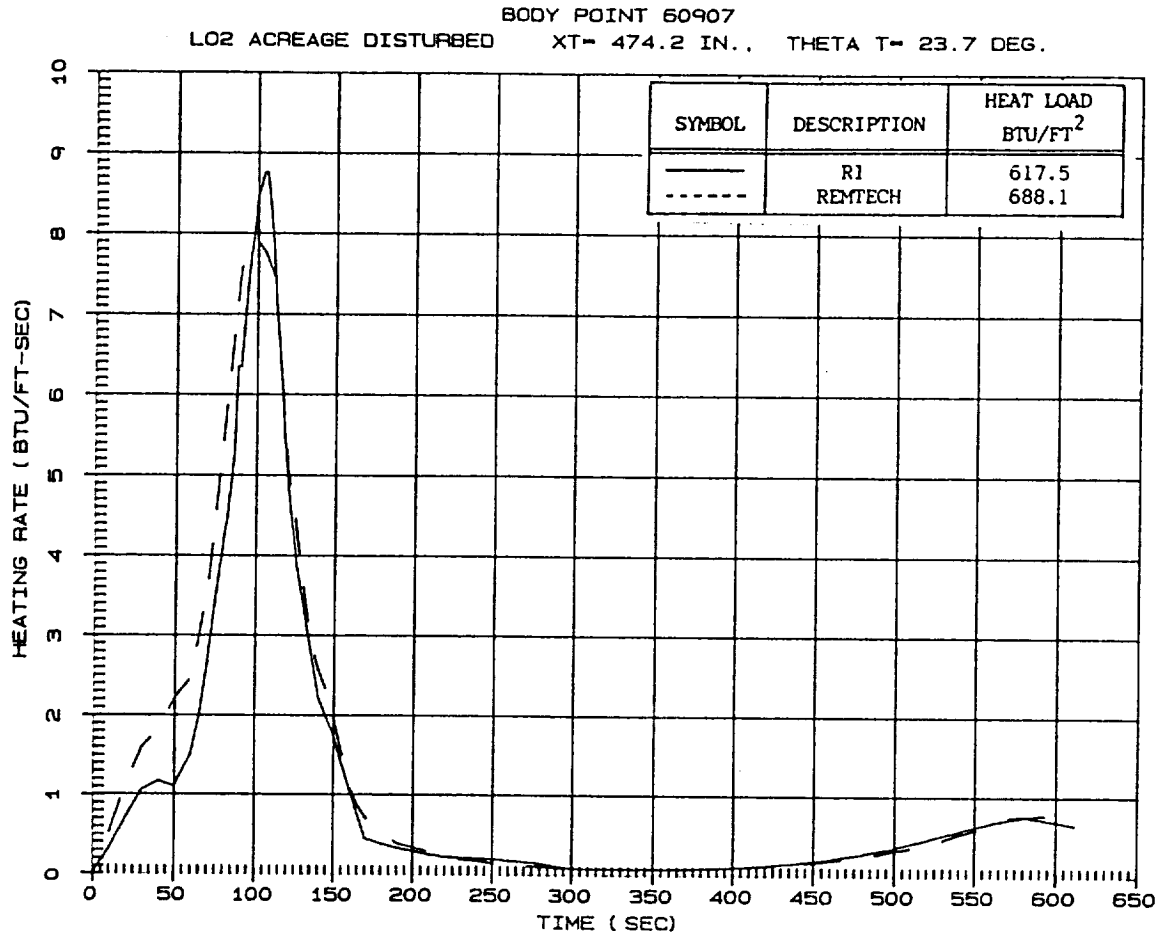

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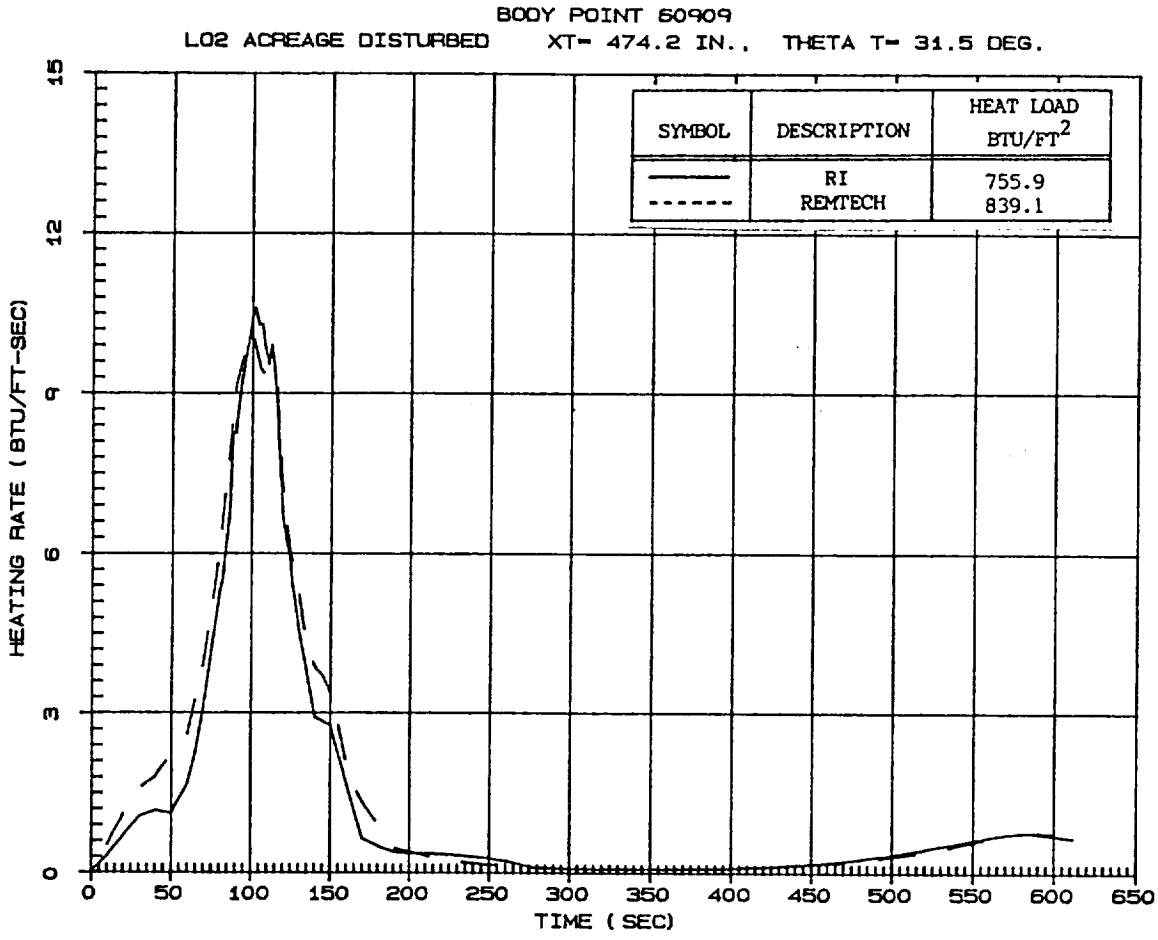

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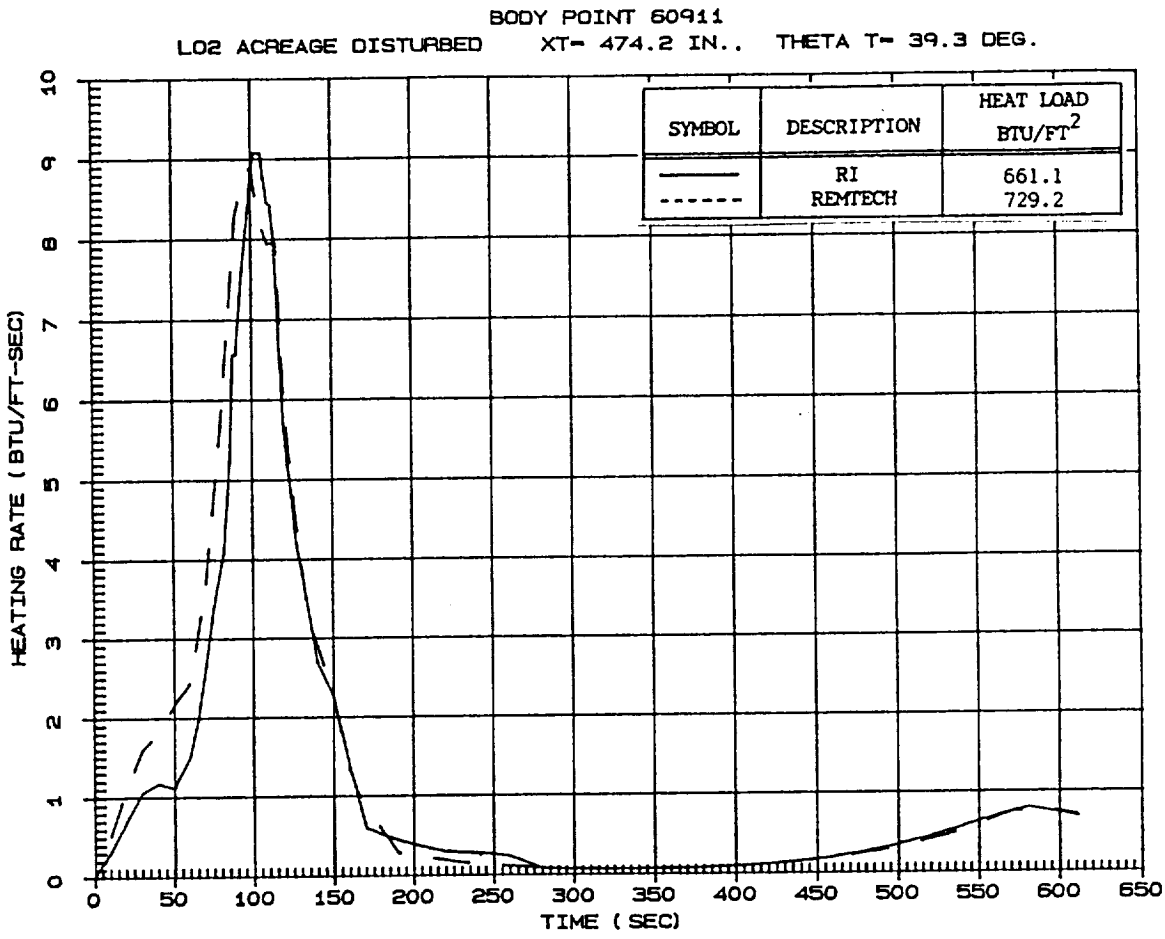

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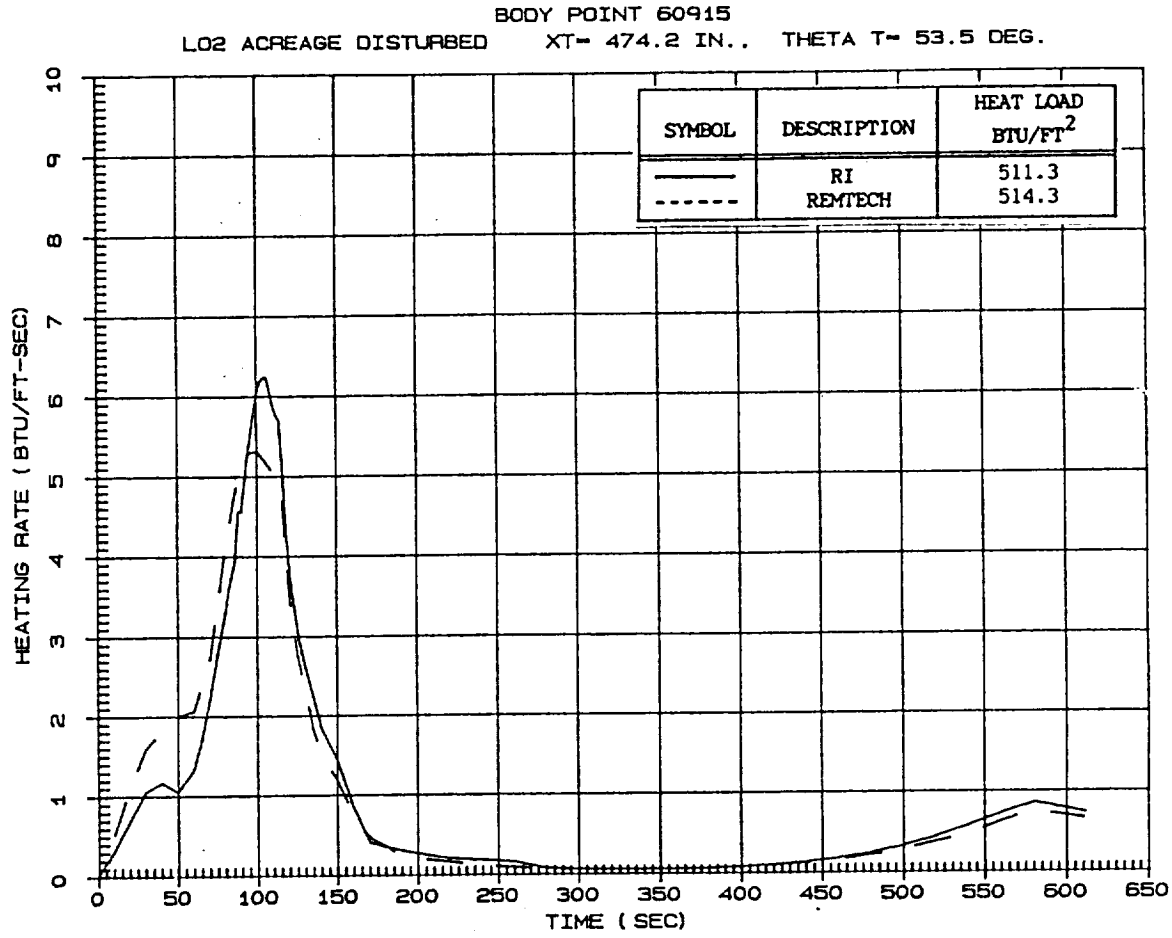

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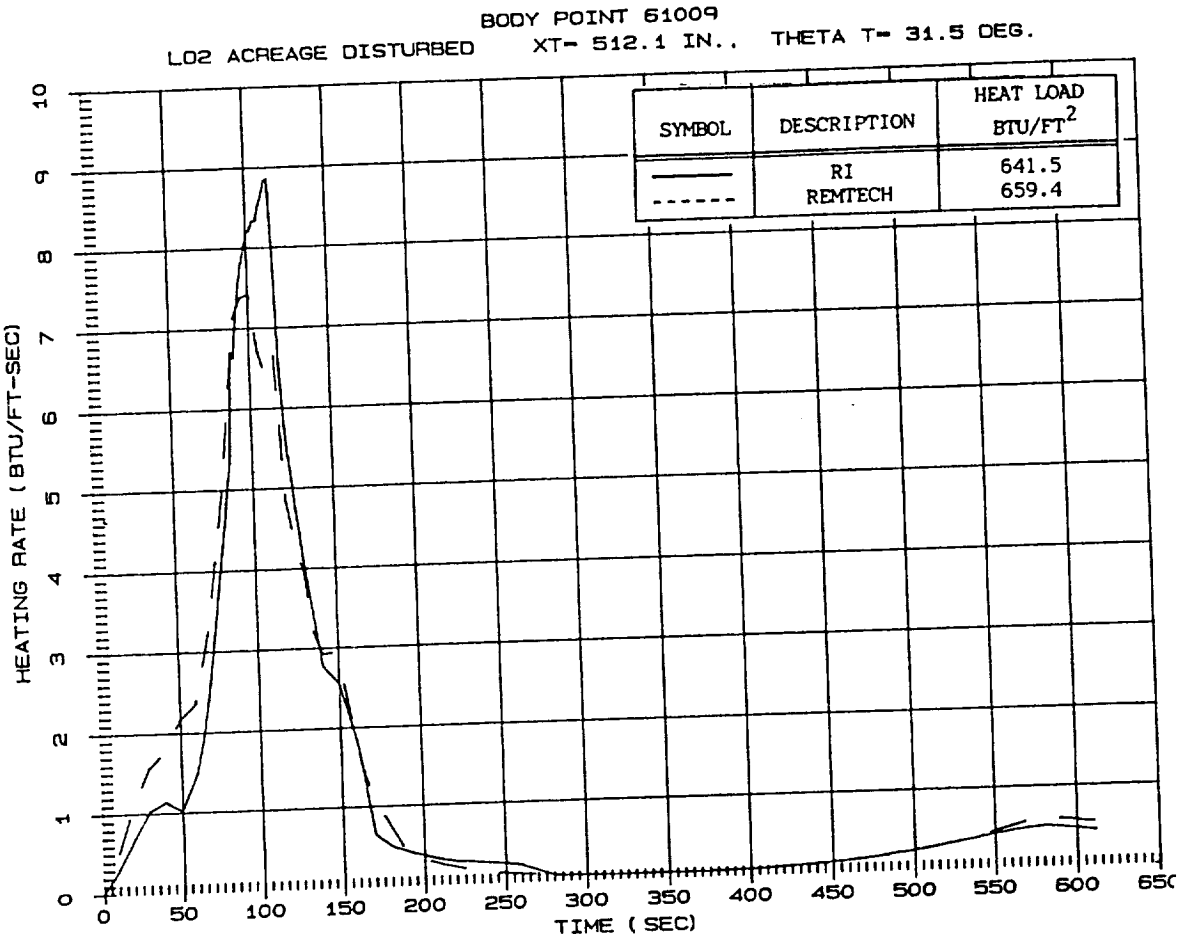

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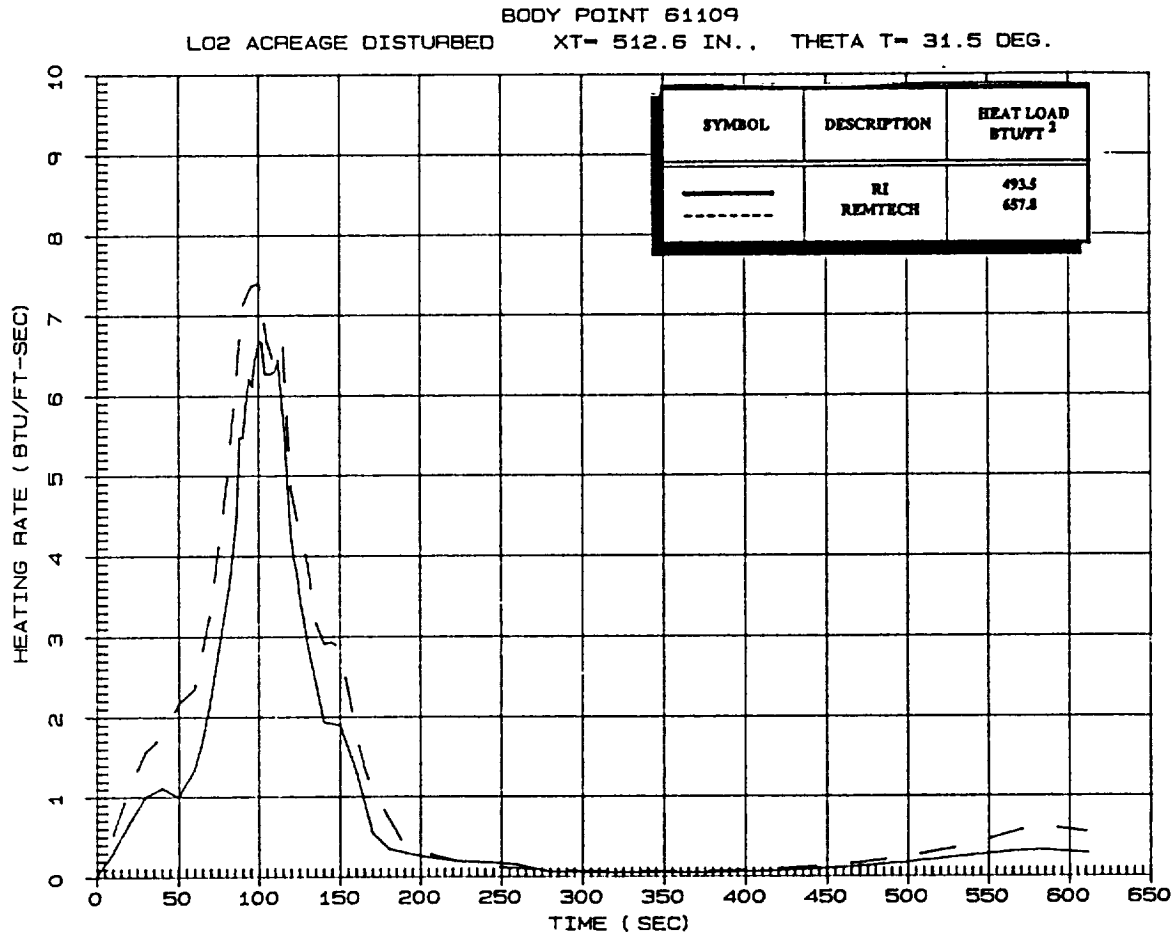

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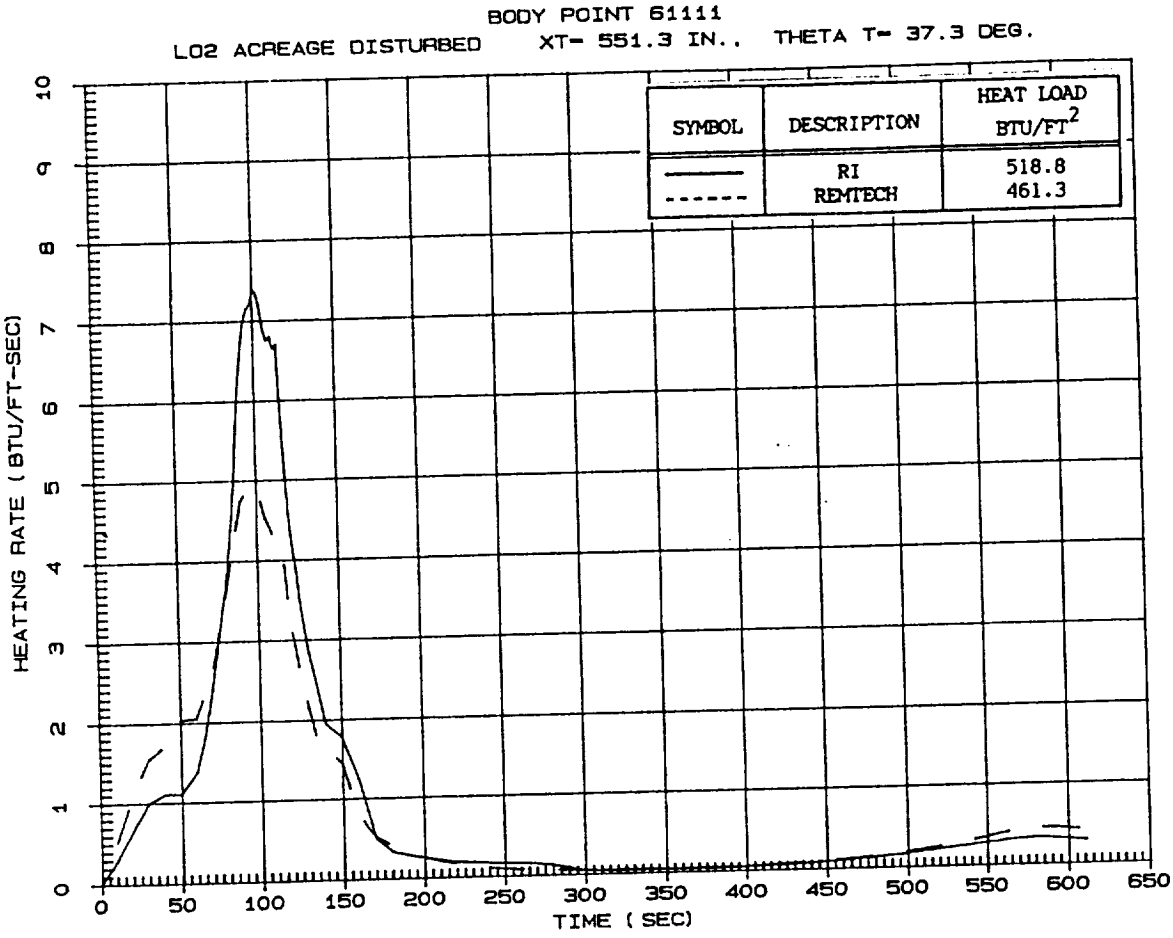
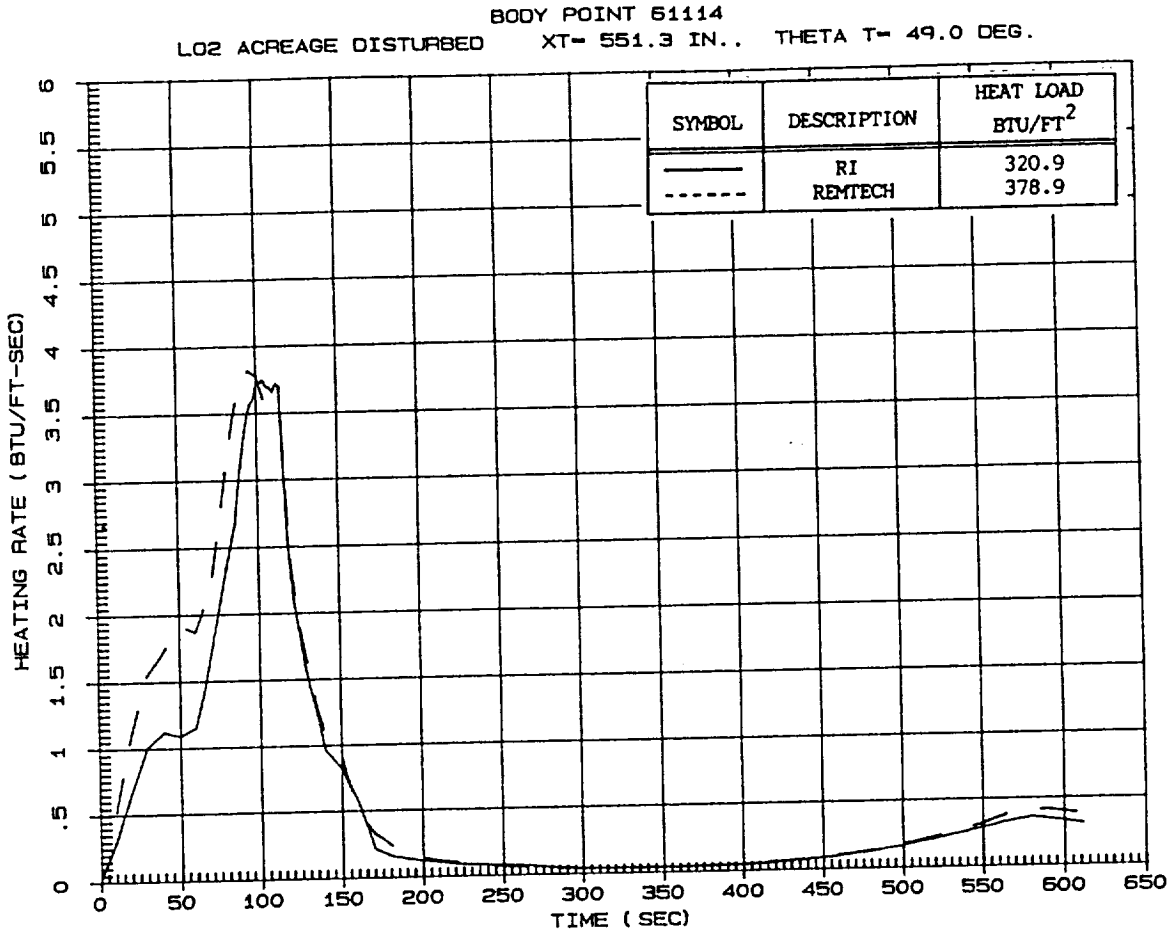
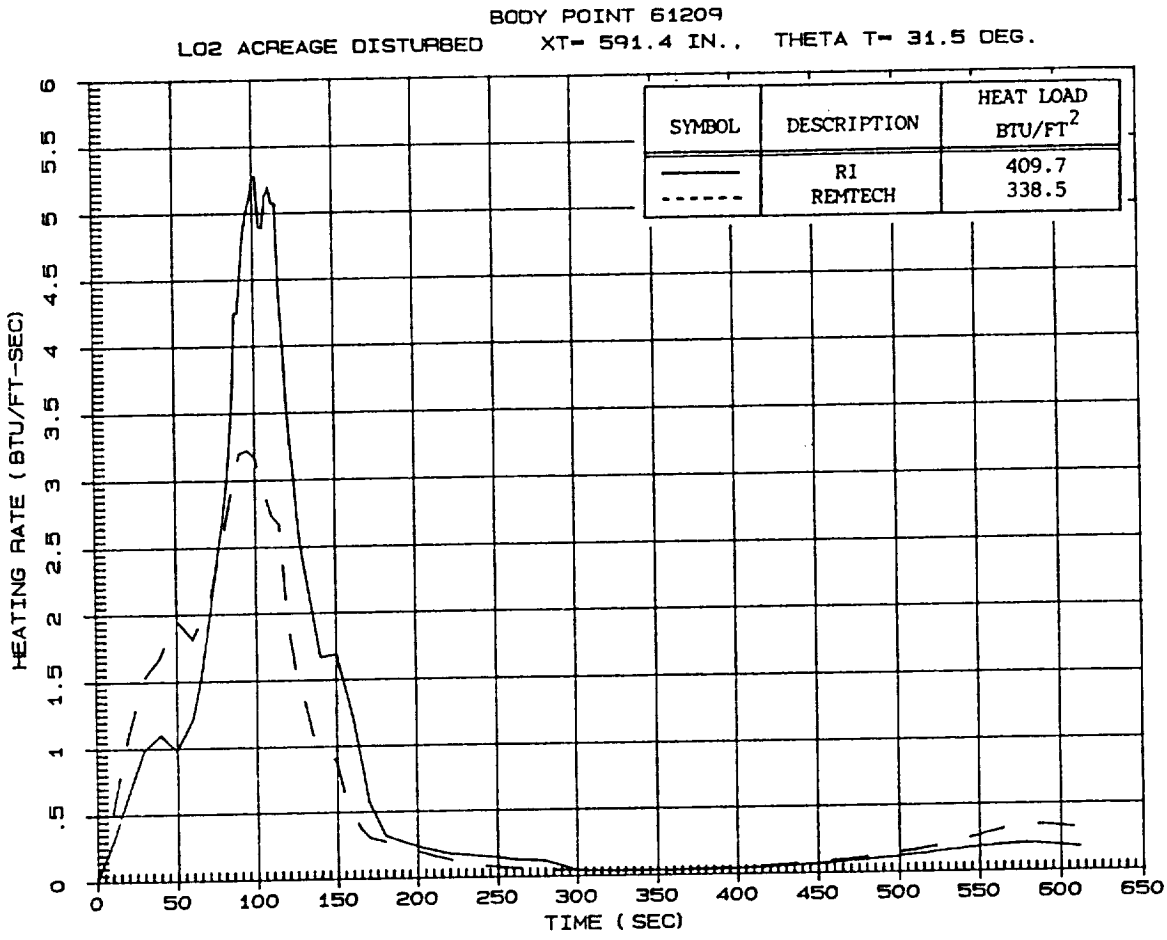


- The difference in max heating rate between Rockwell and REMTECH generates < 0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

Agreement is acceptable; no TPS impact.

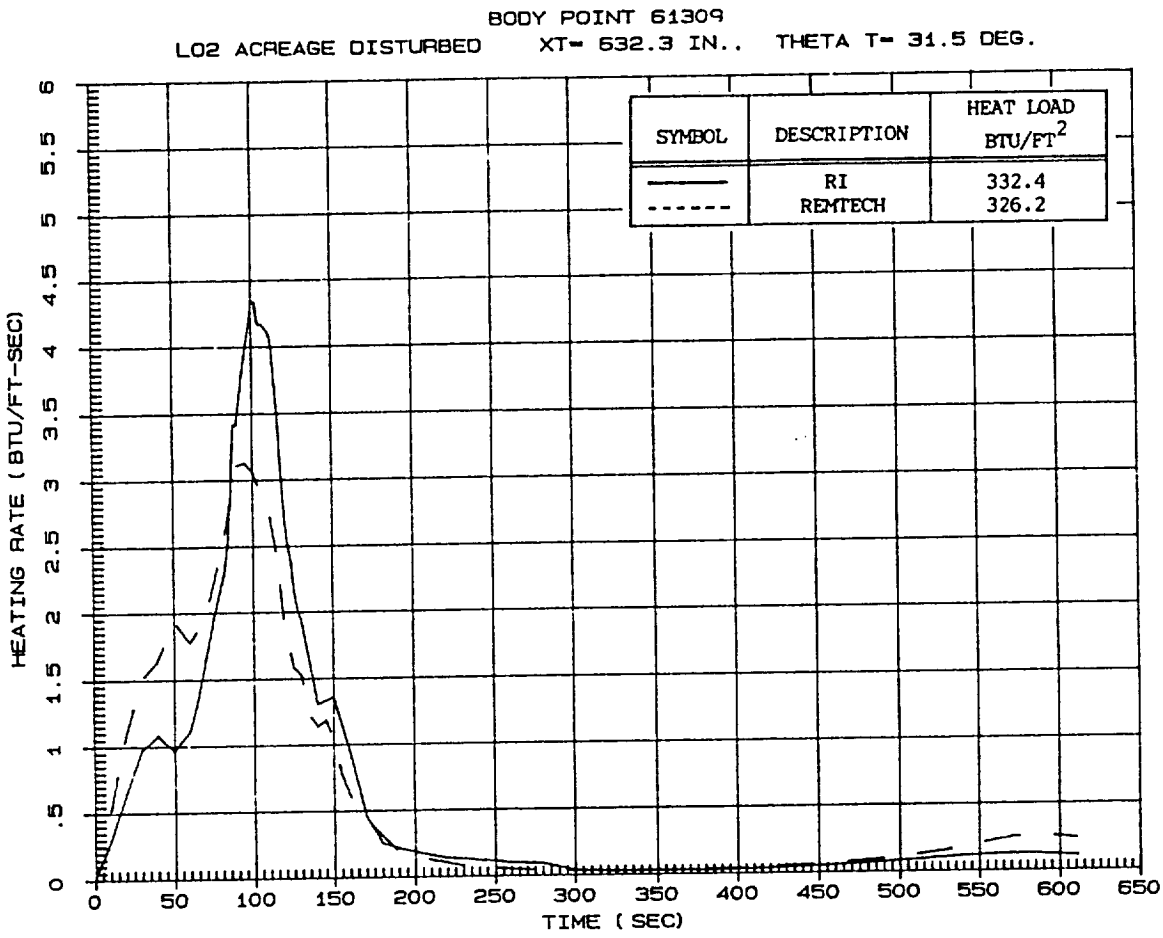


Agreement is acceptable; no TPS impact.

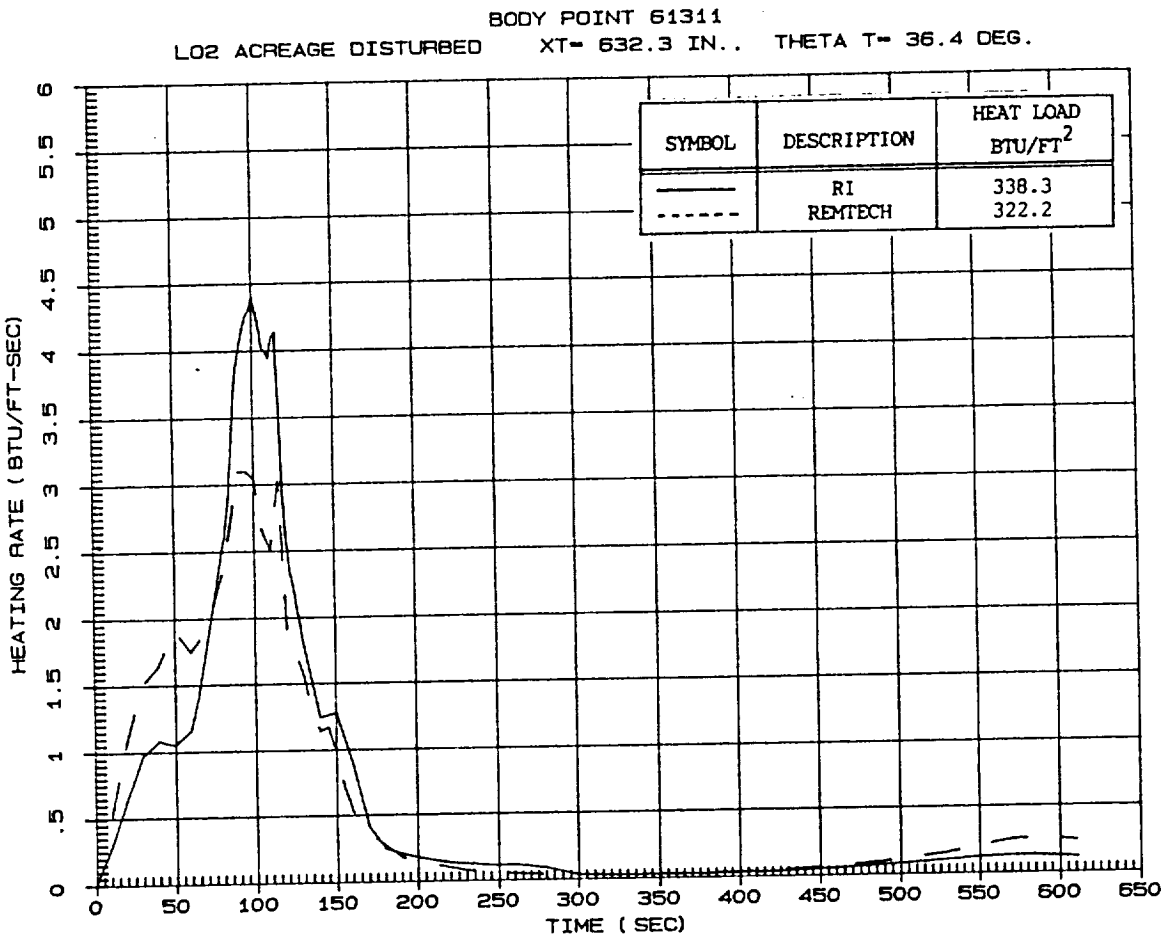


- The difference in maximum heating rate between Rockwell and REMTECH generates into a difference of ~ 0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



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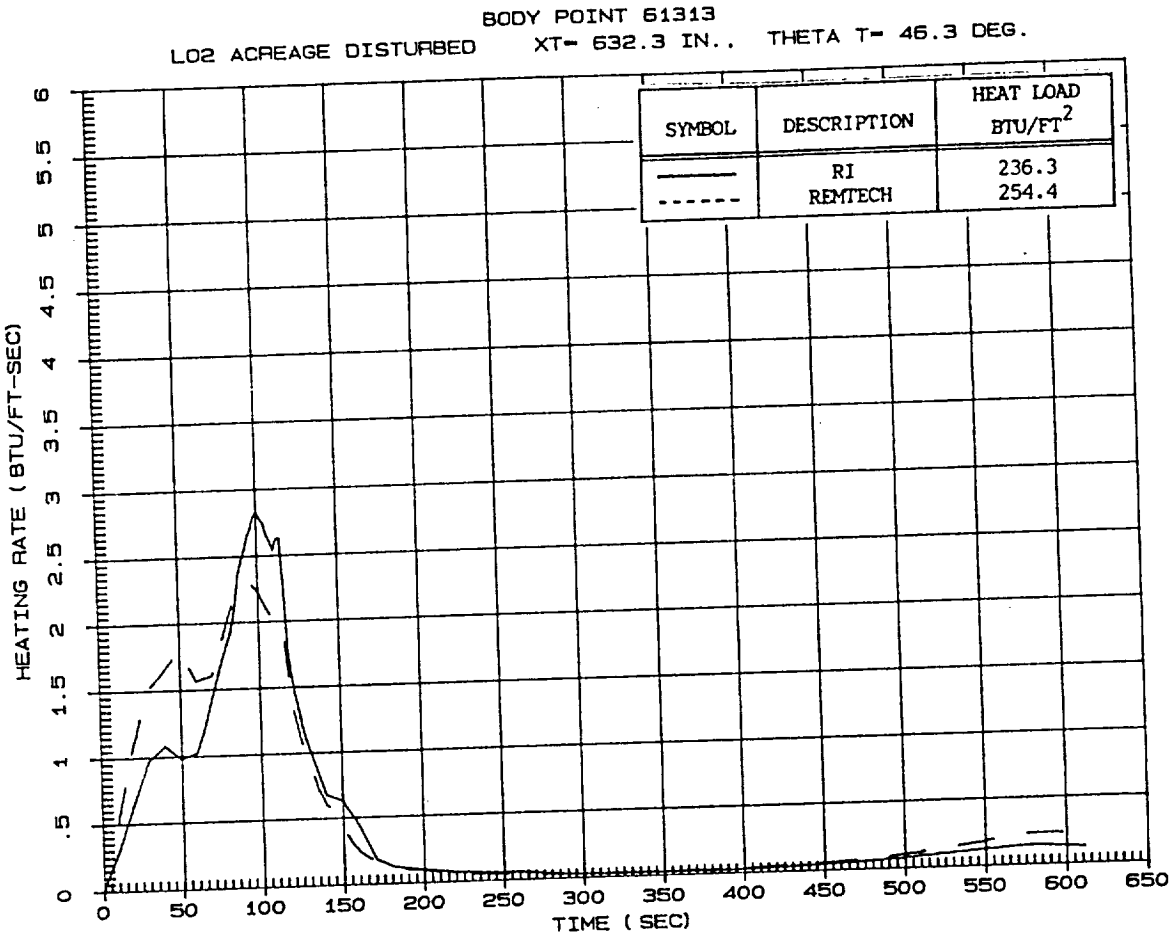

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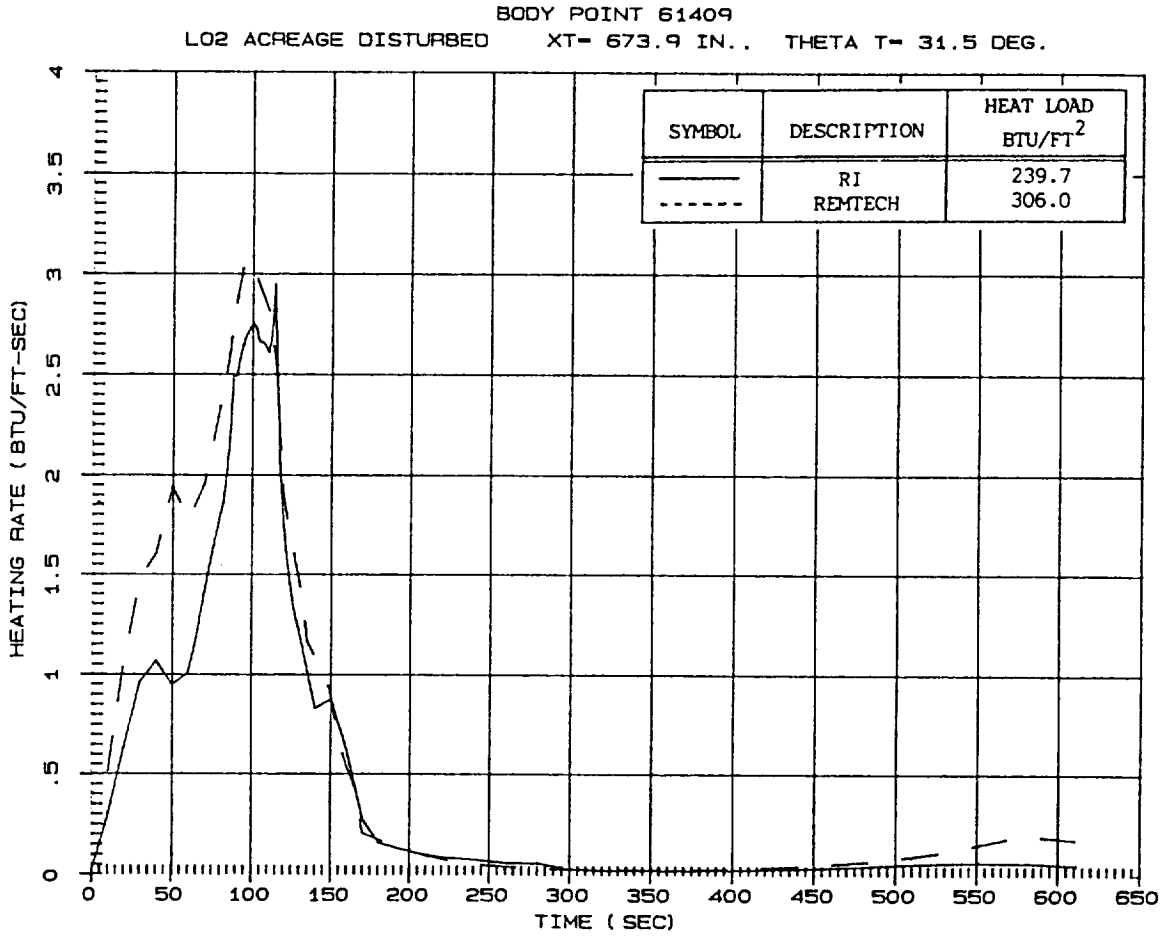

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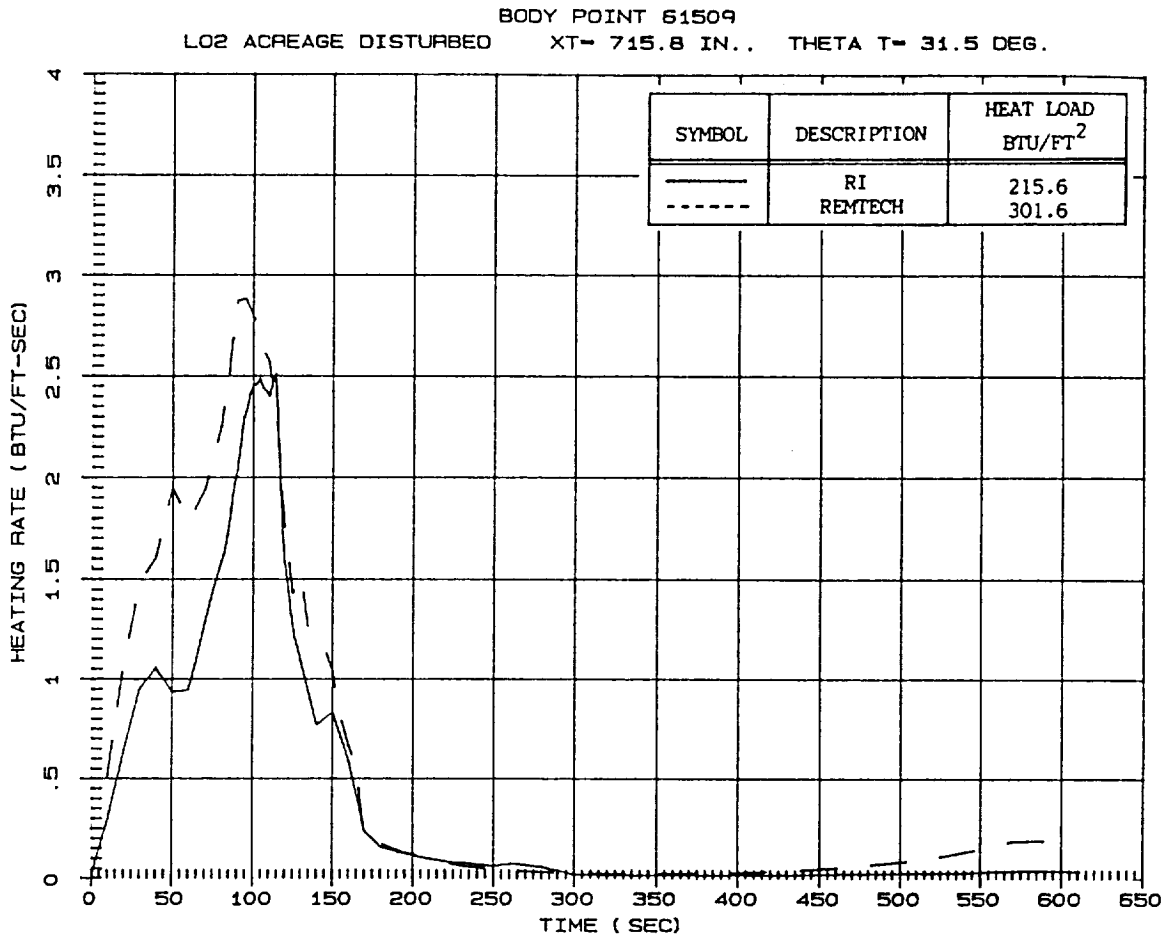

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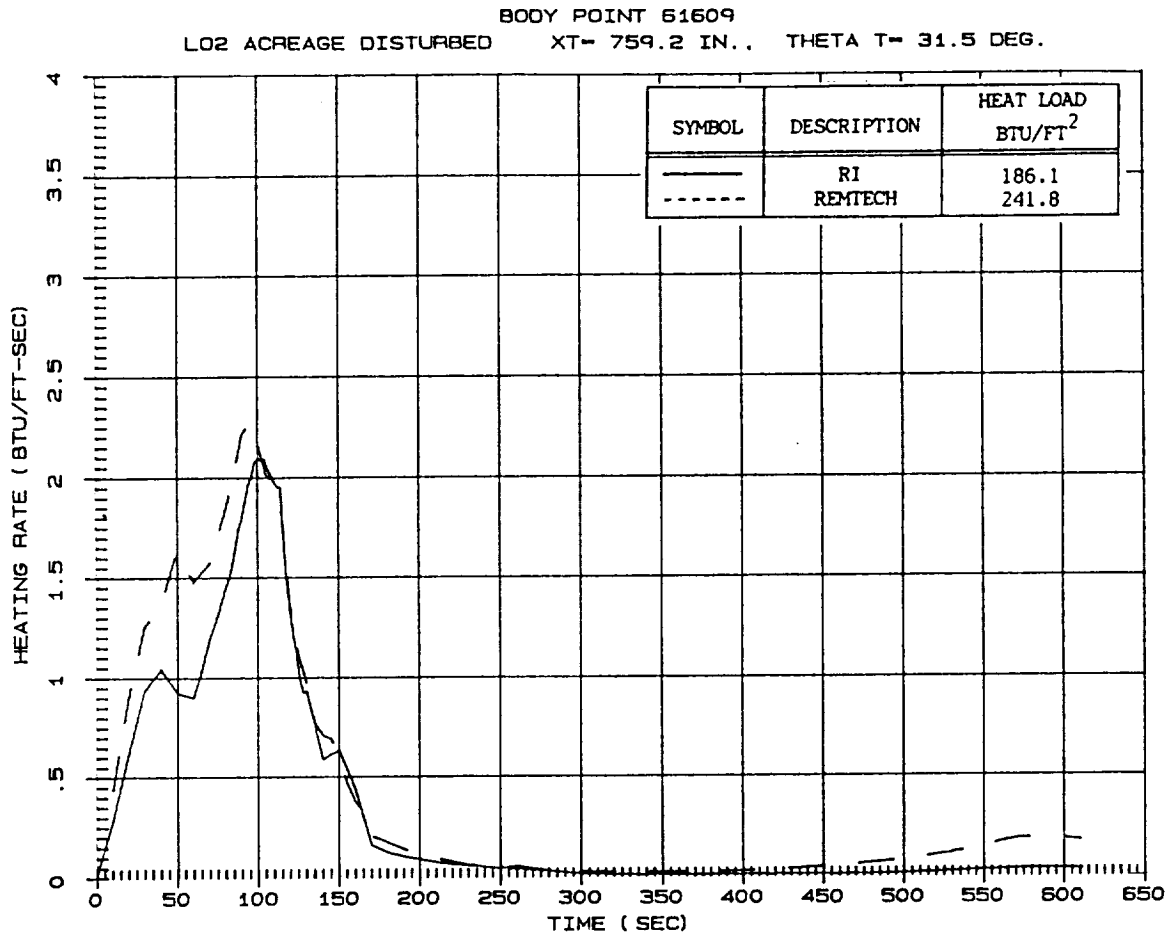

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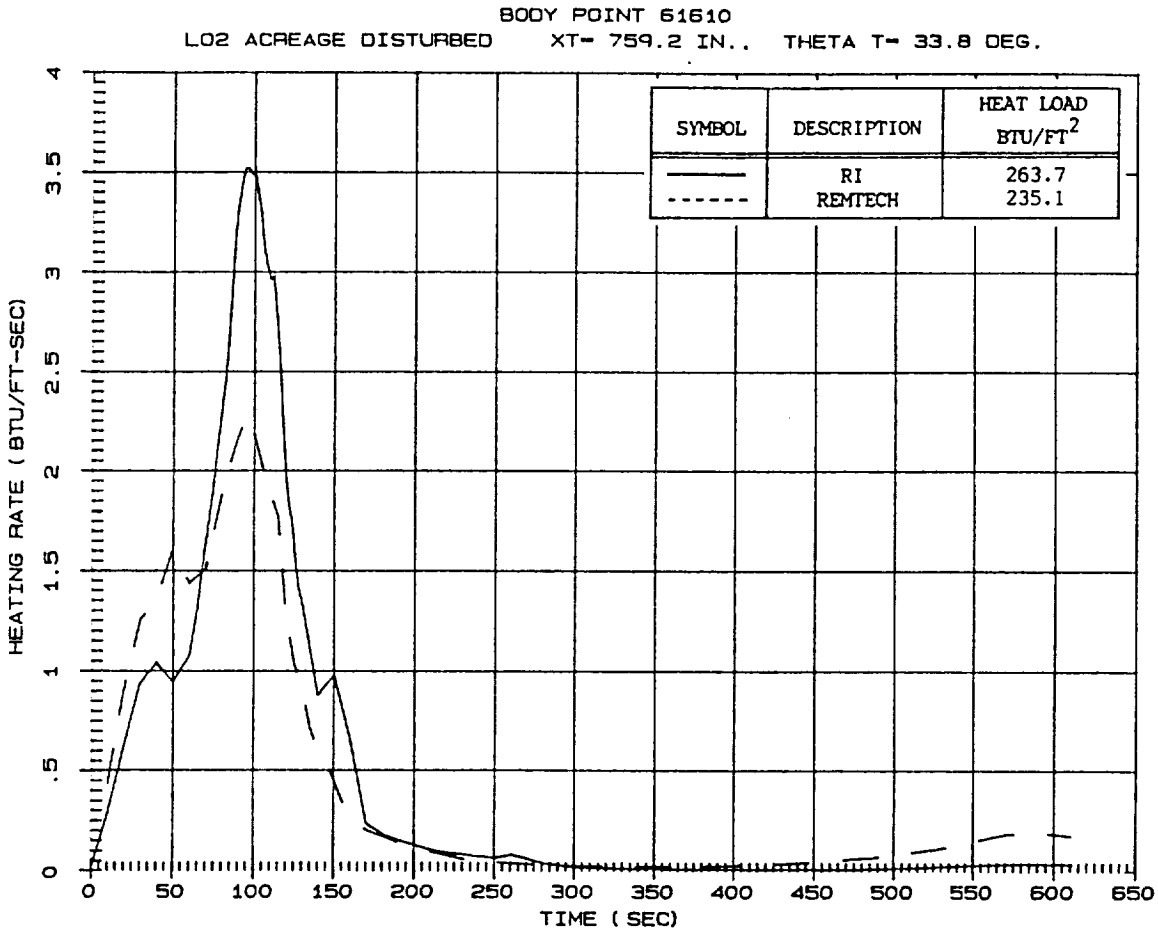

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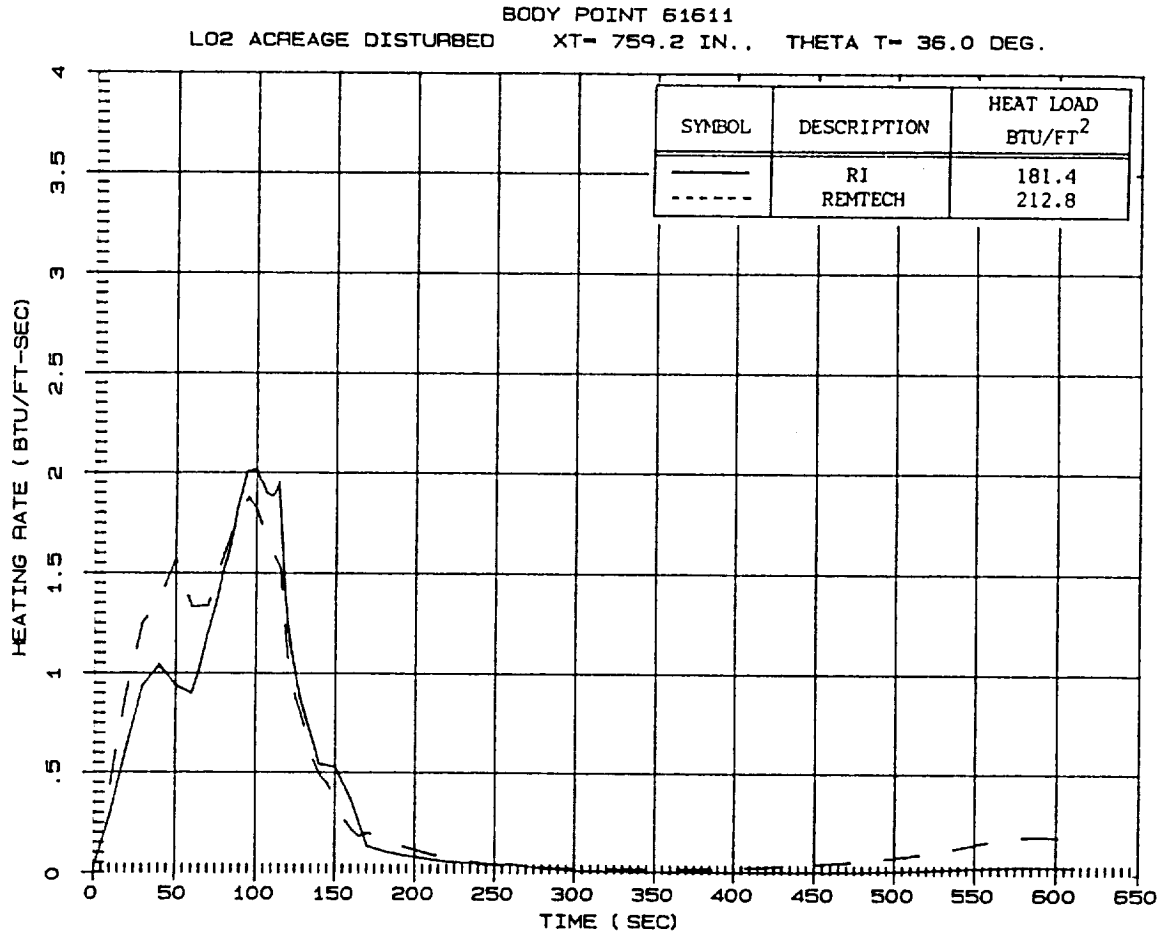

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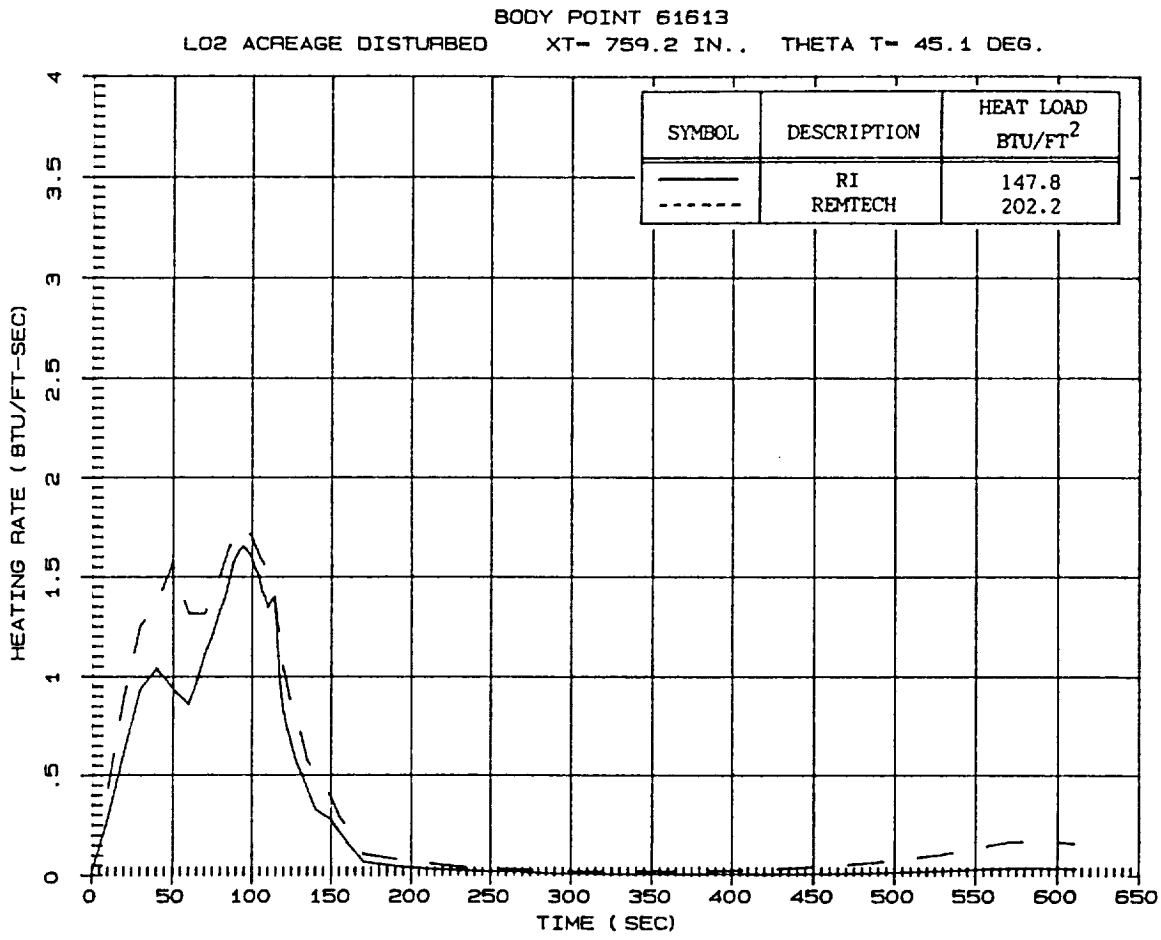

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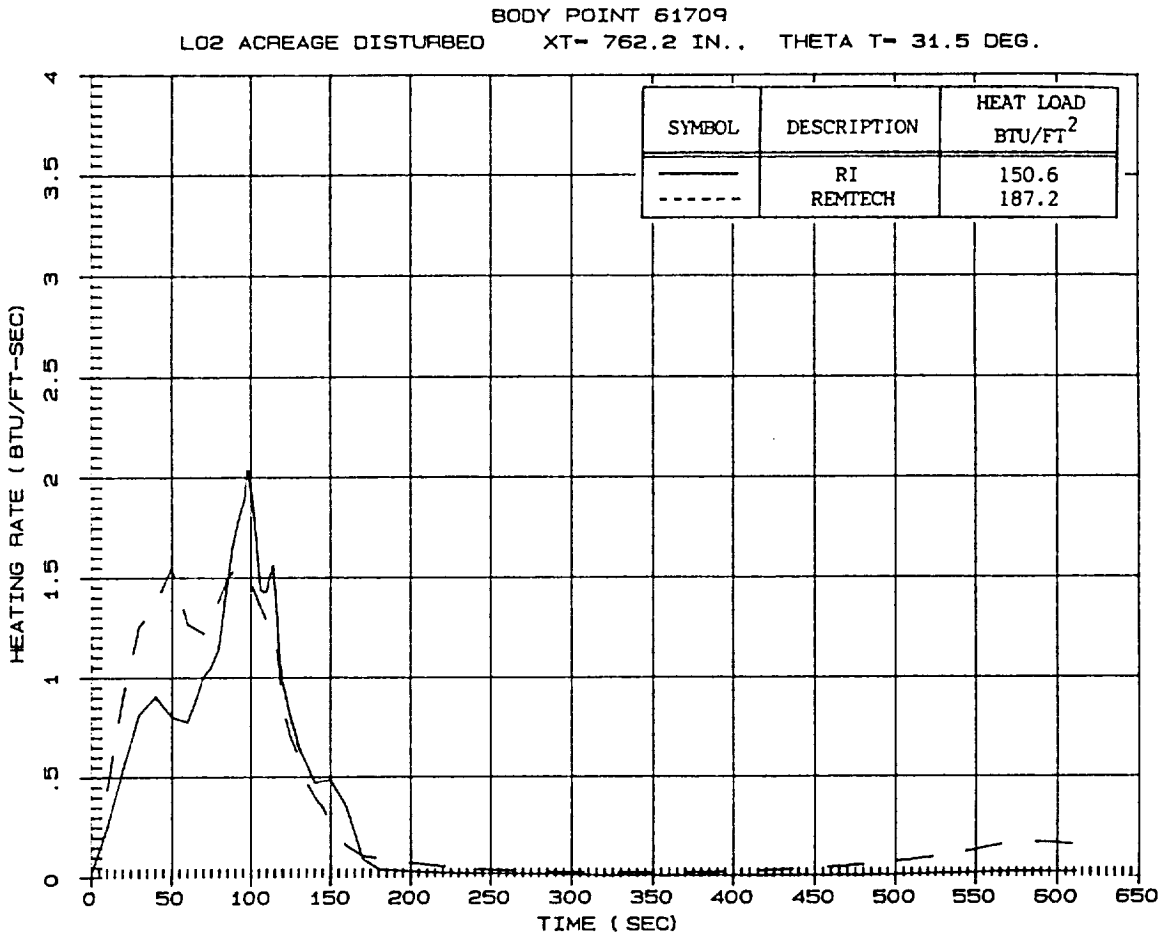

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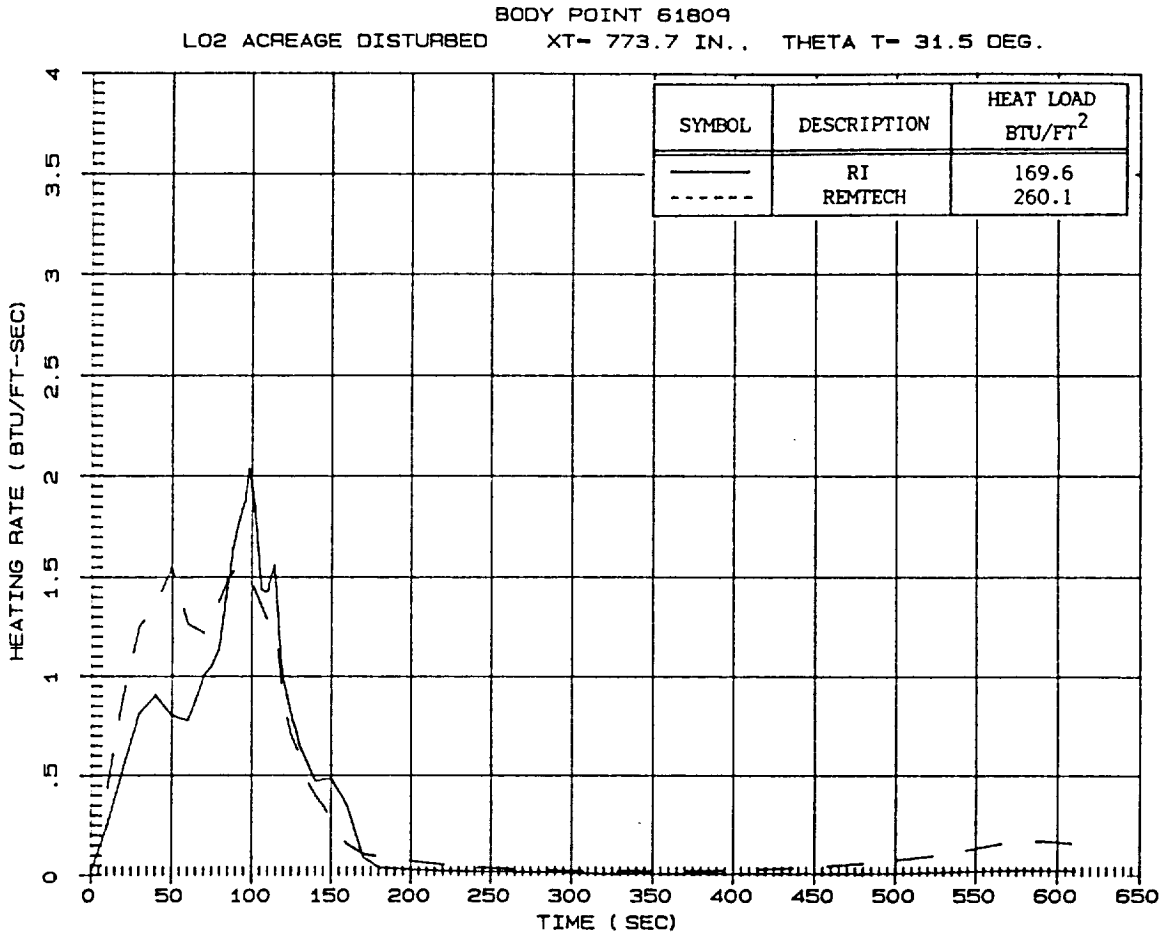

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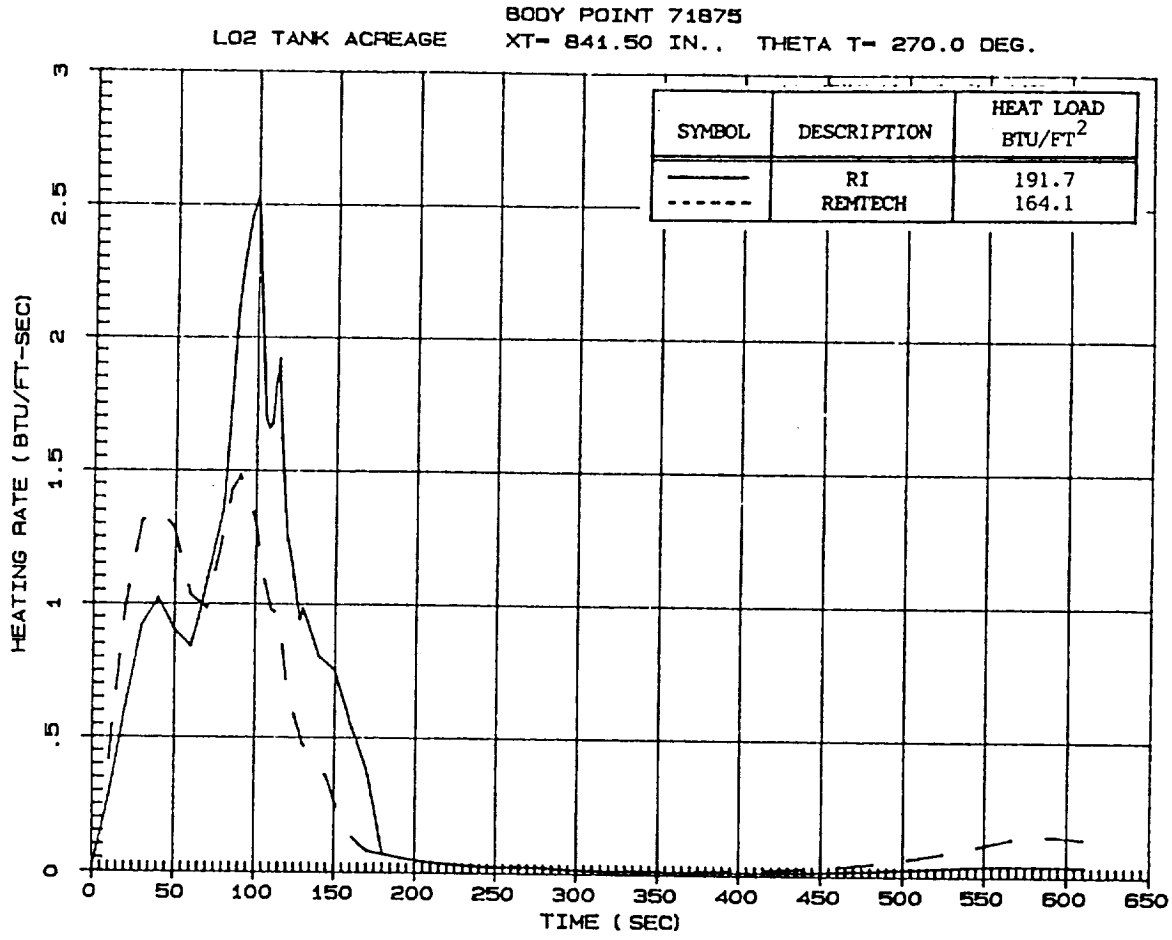

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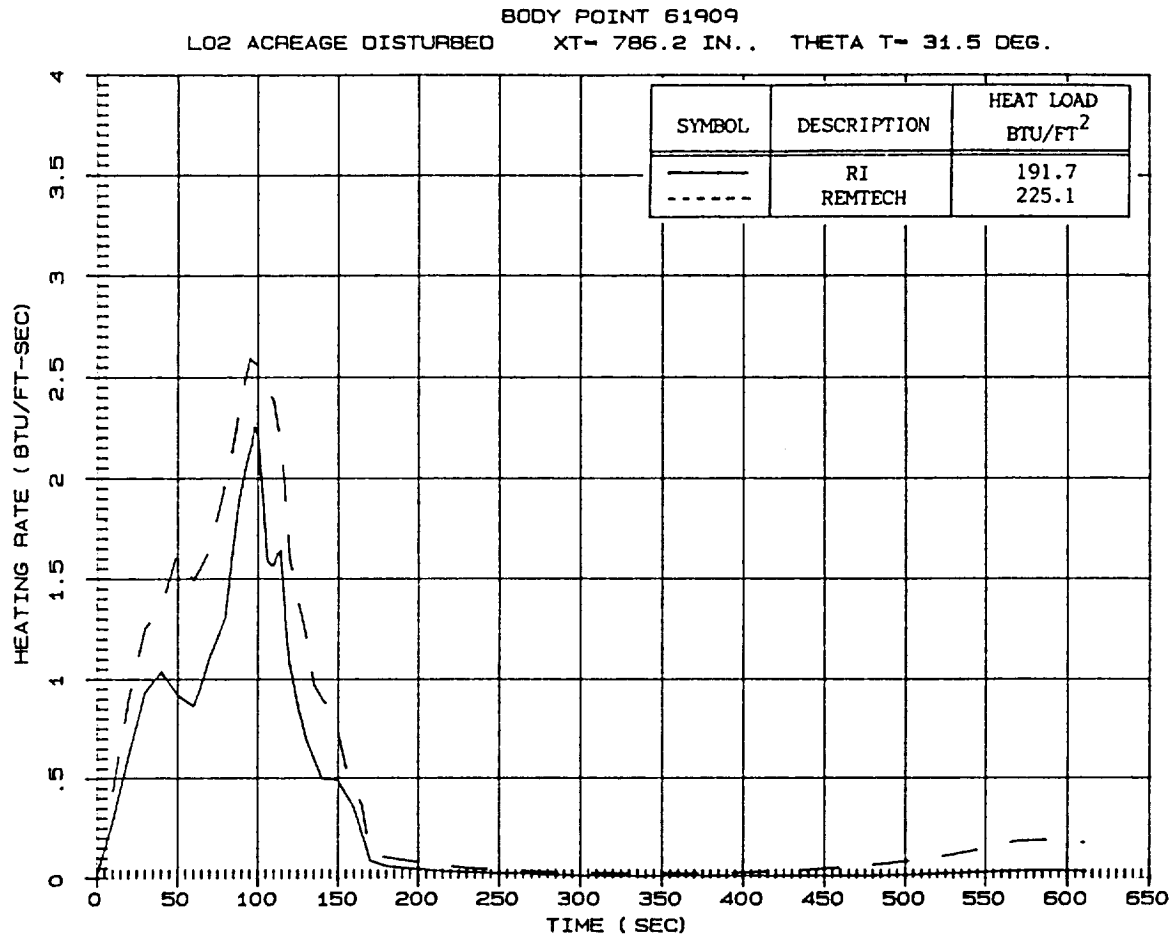

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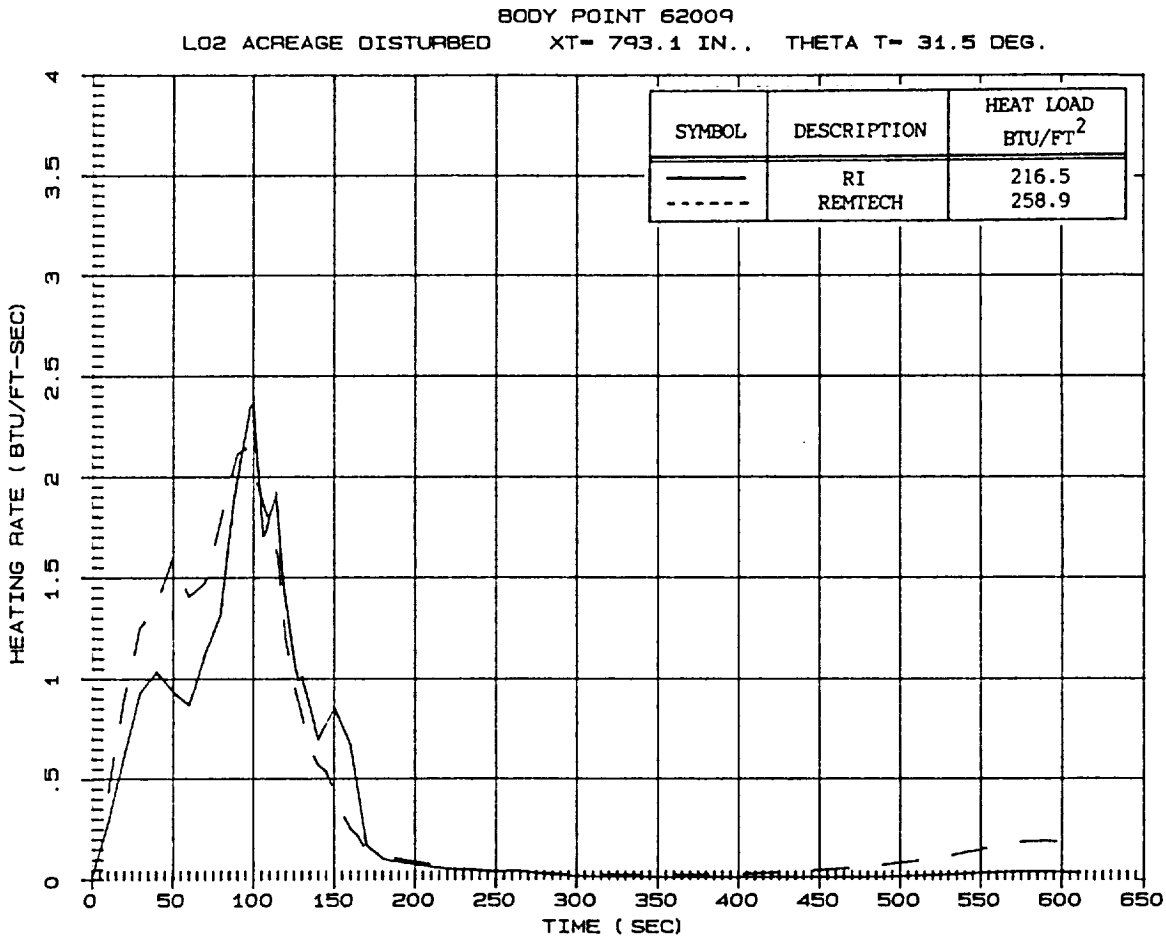

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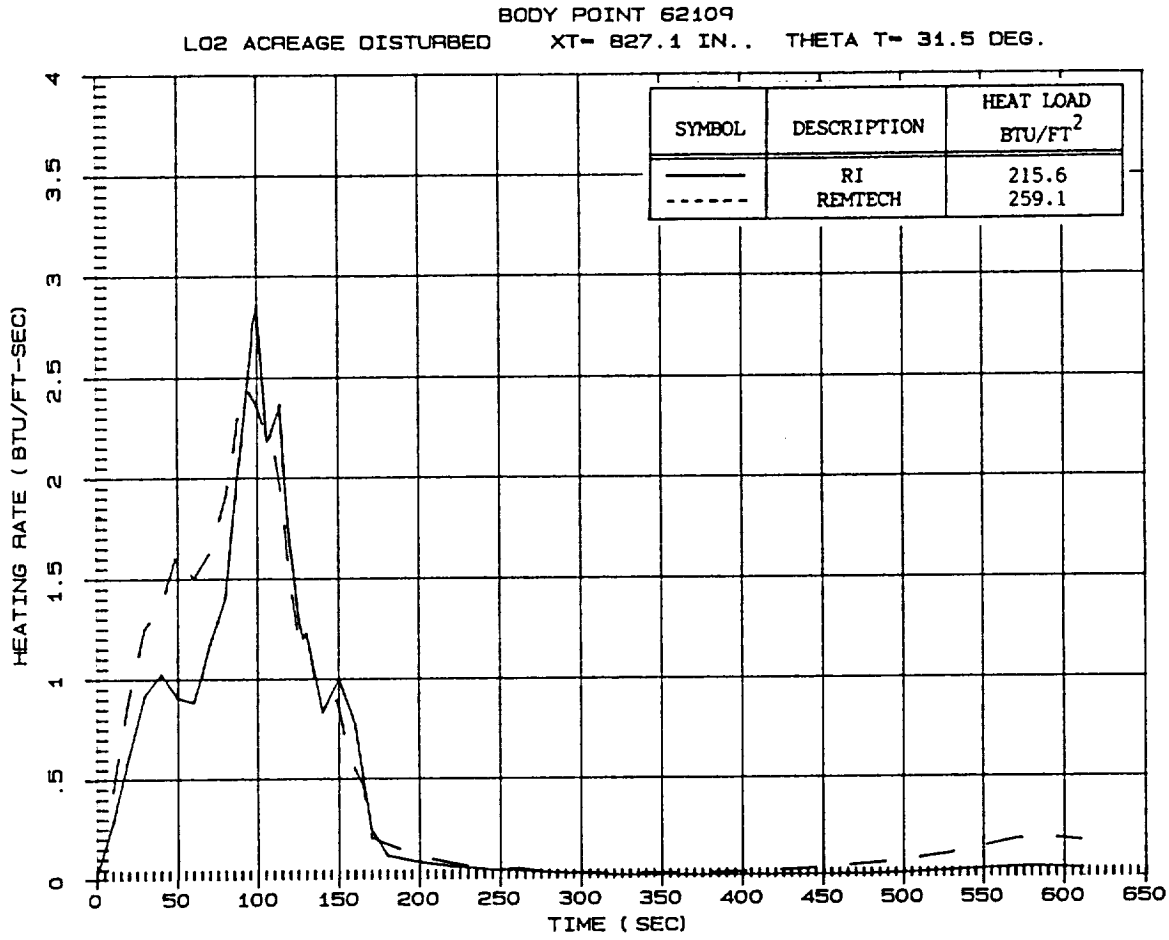

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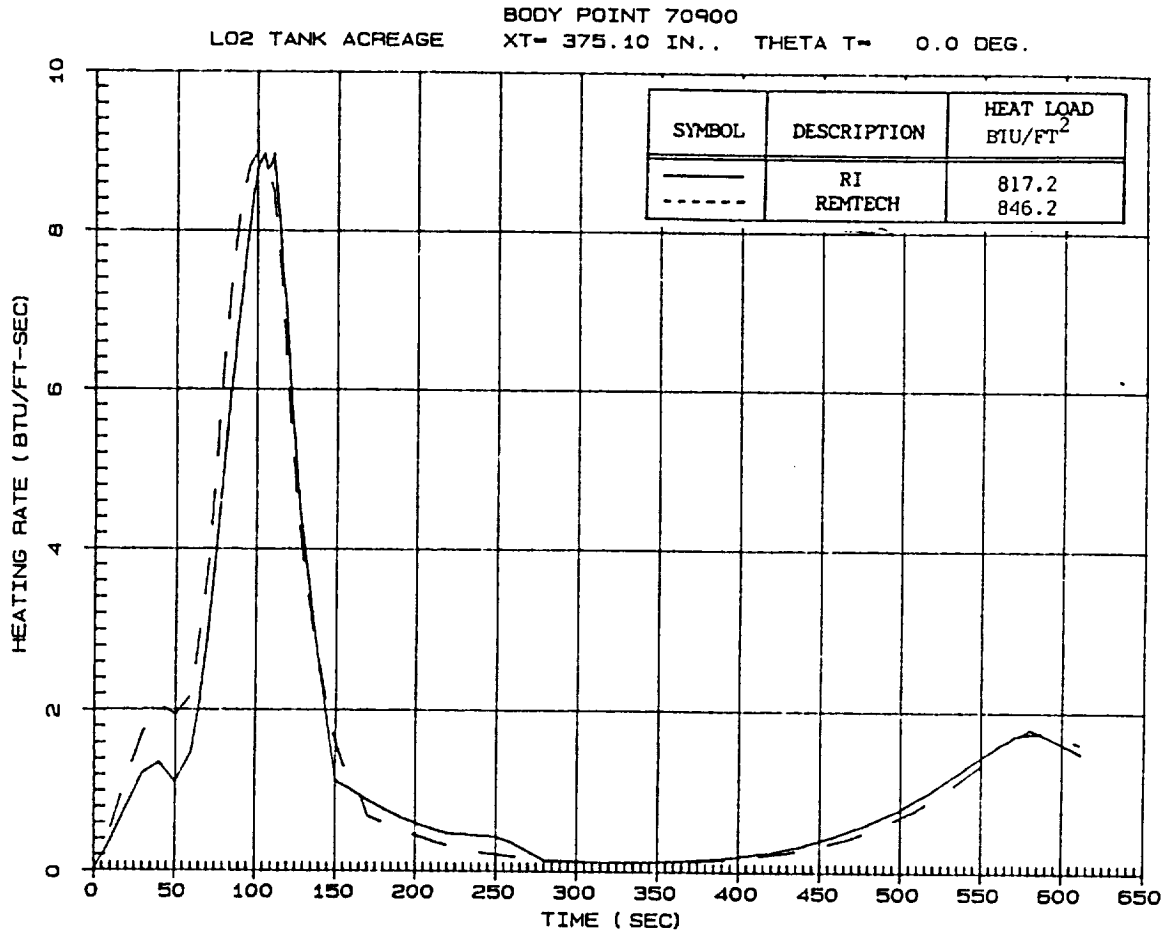

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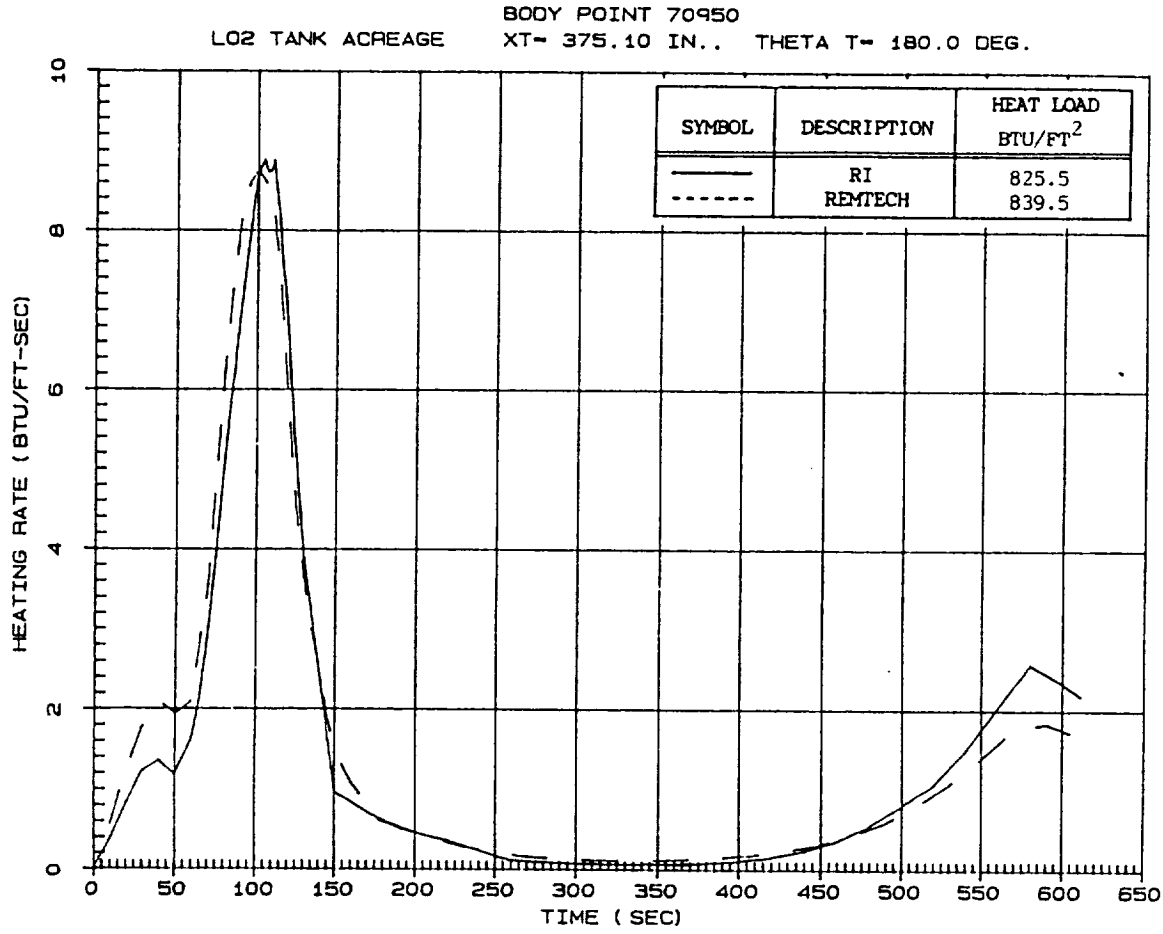

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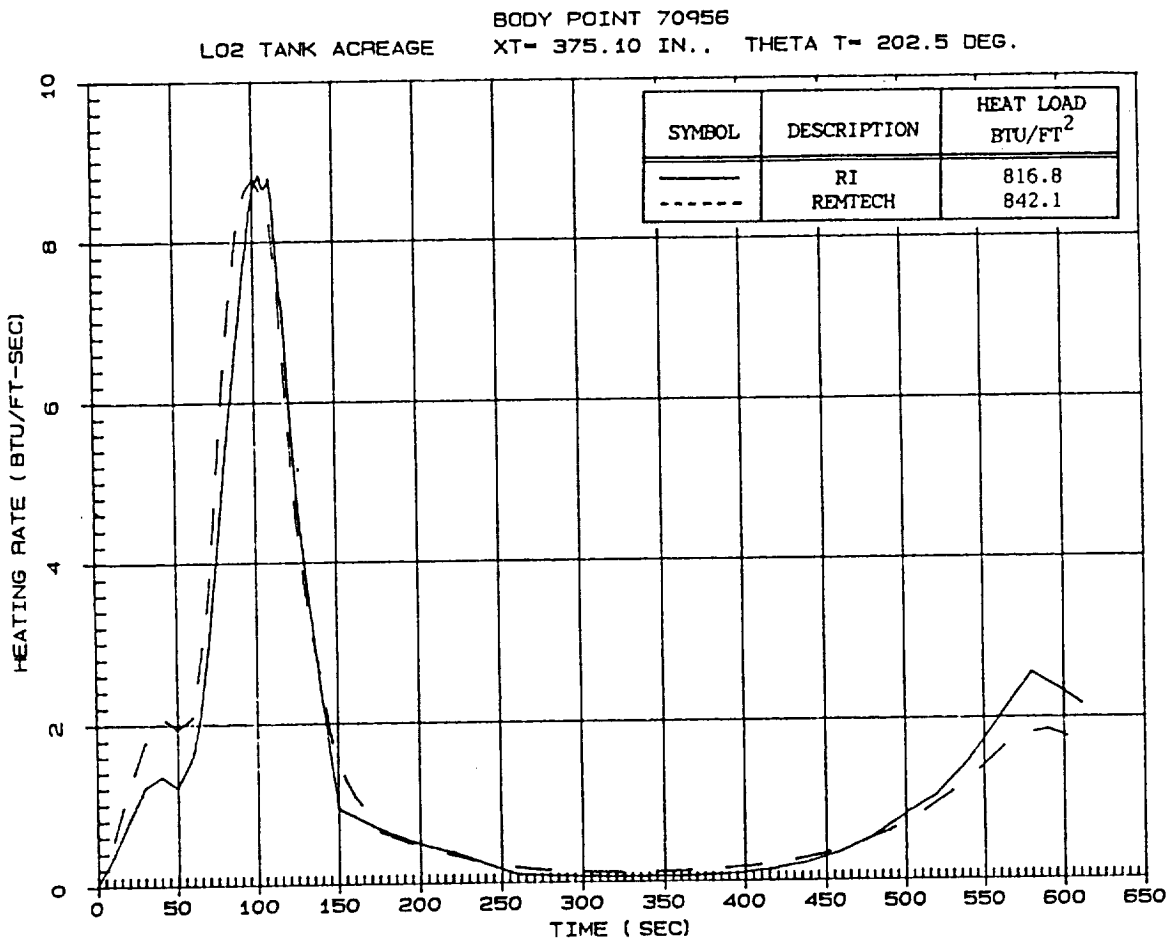

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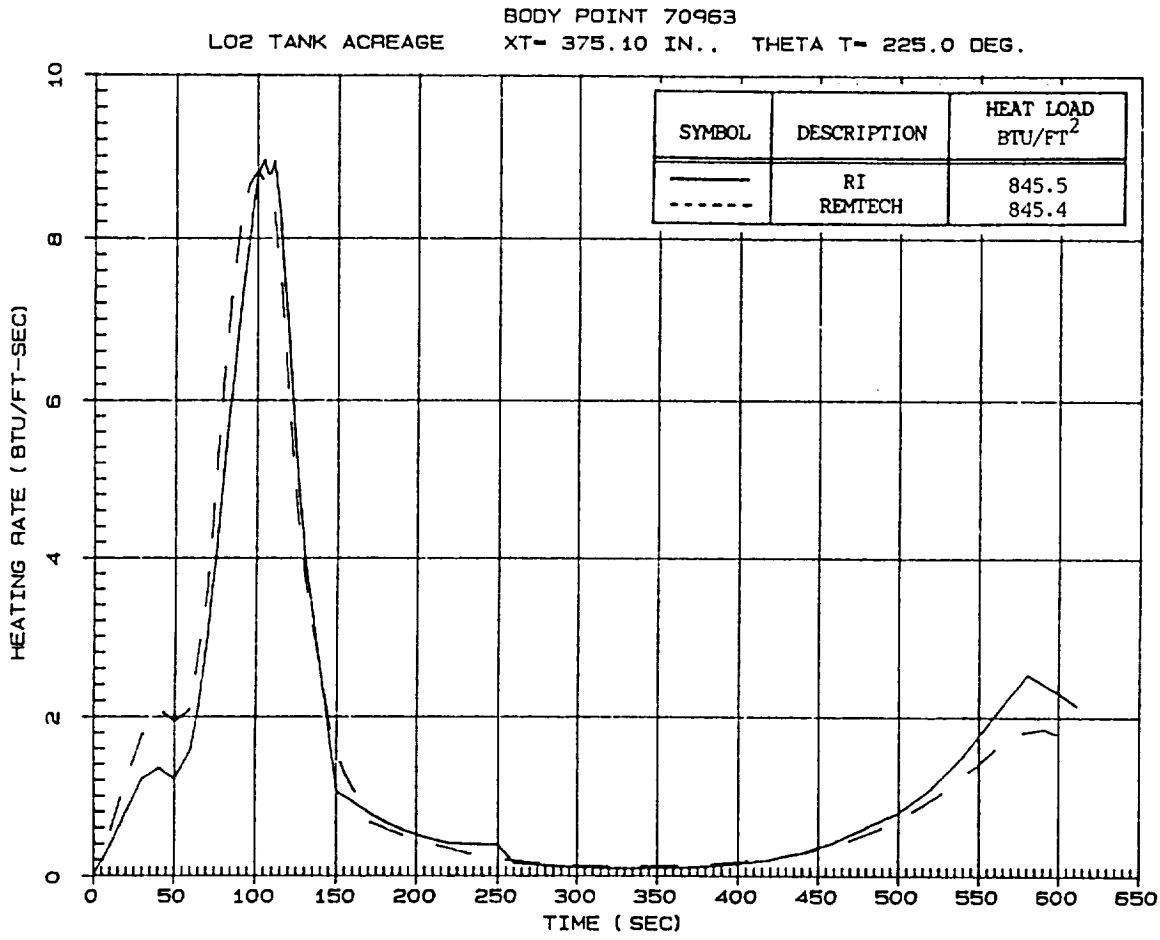

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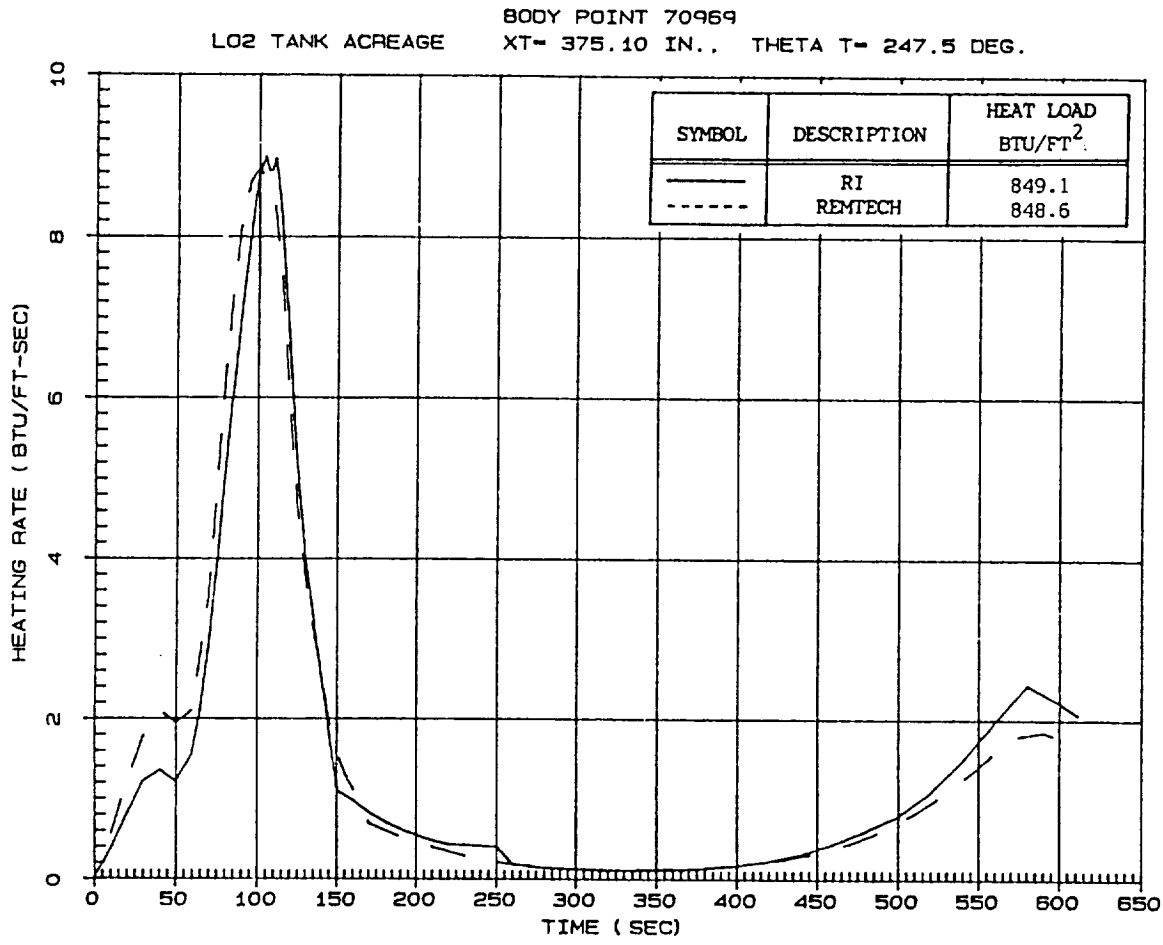

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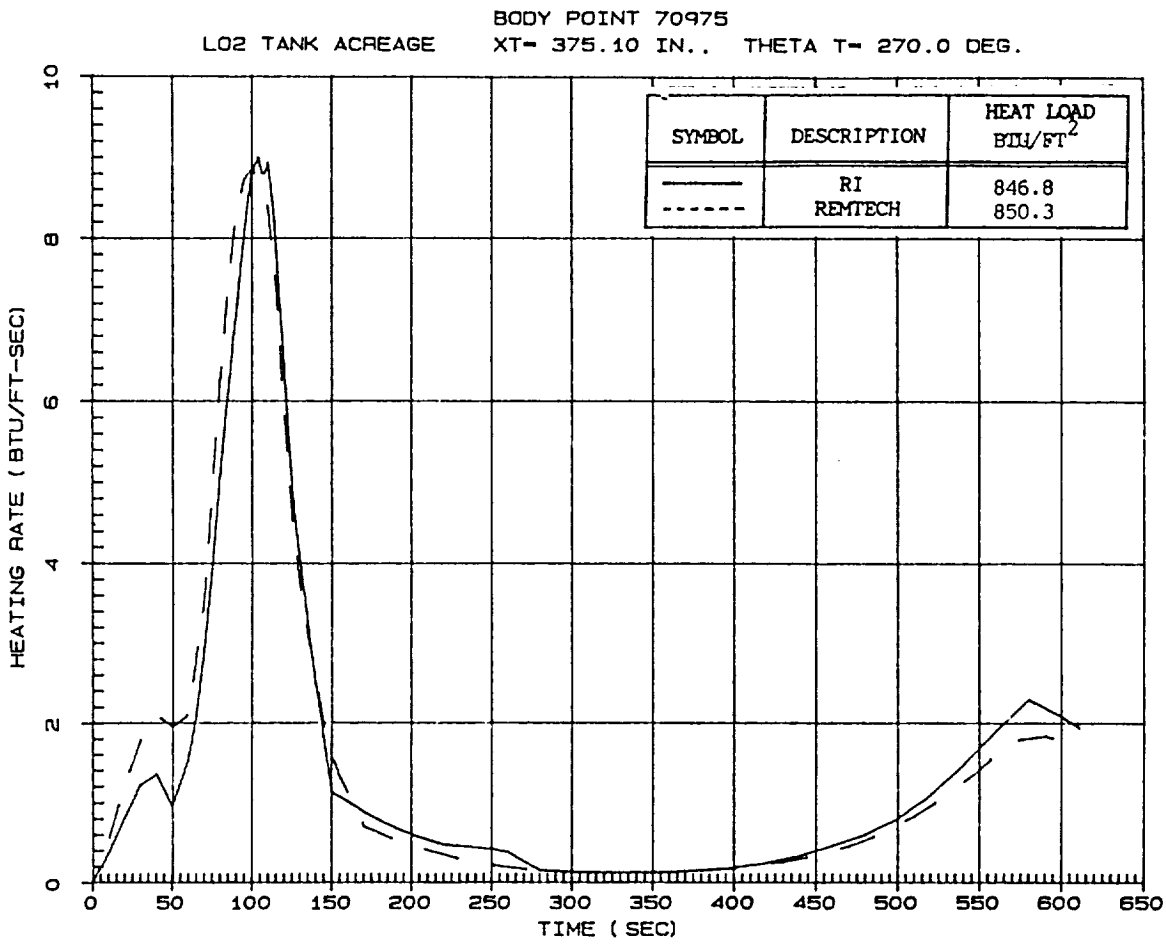

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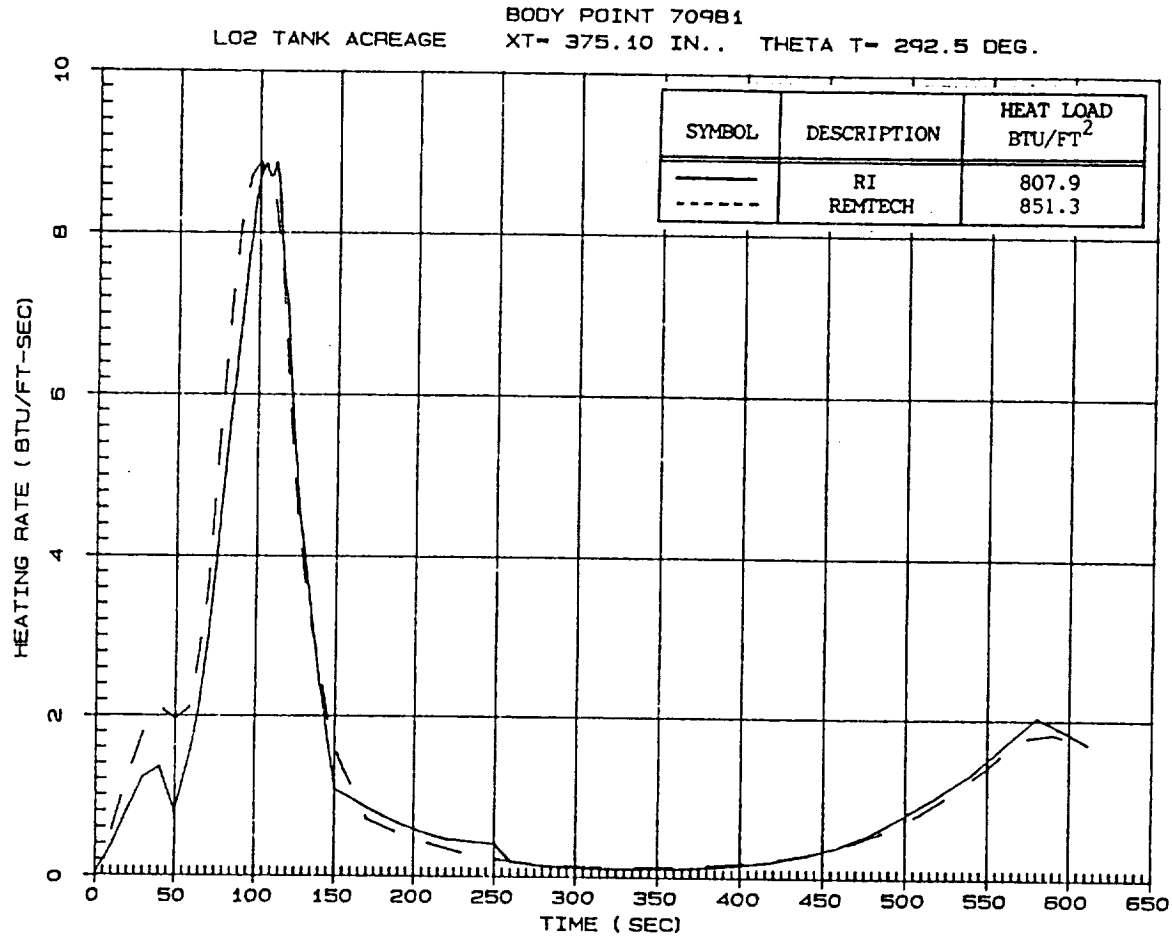

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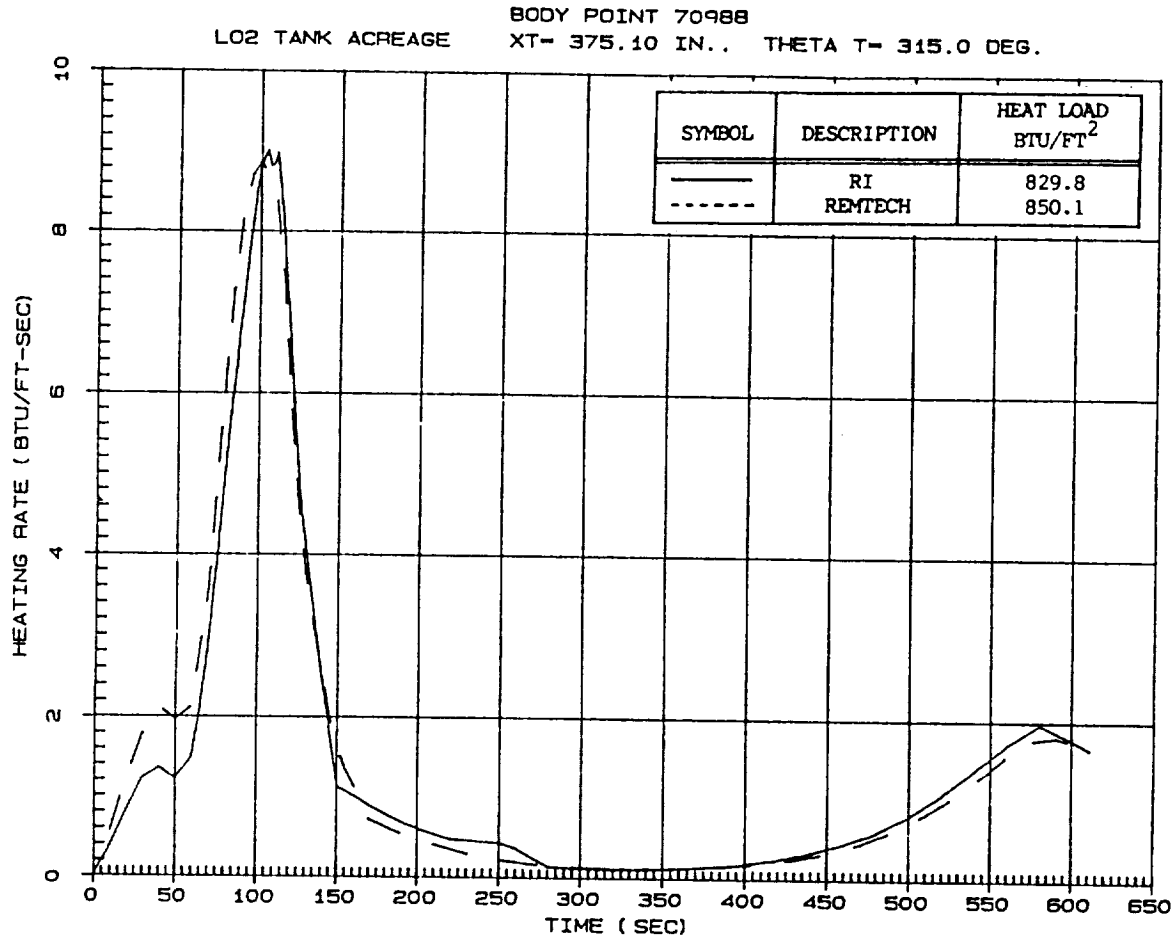

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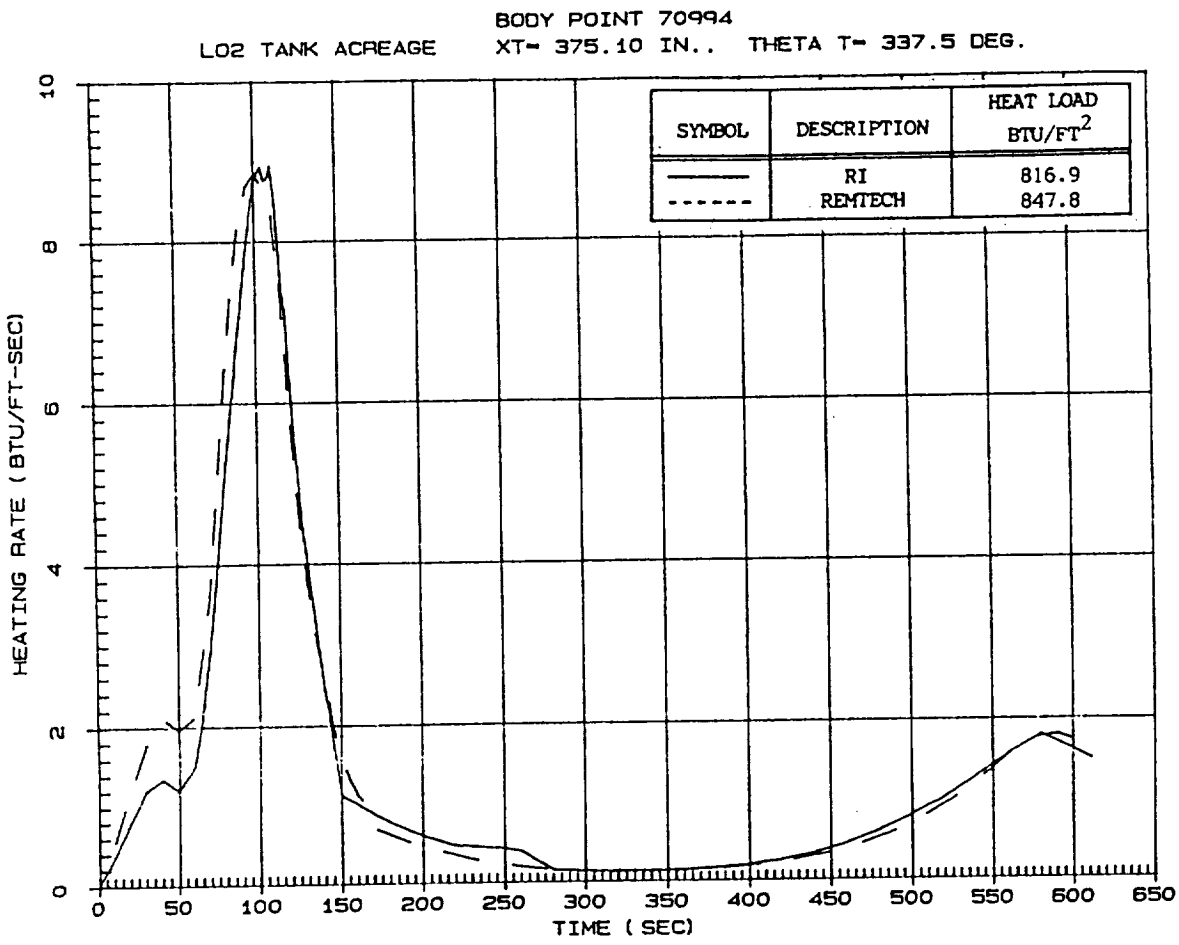

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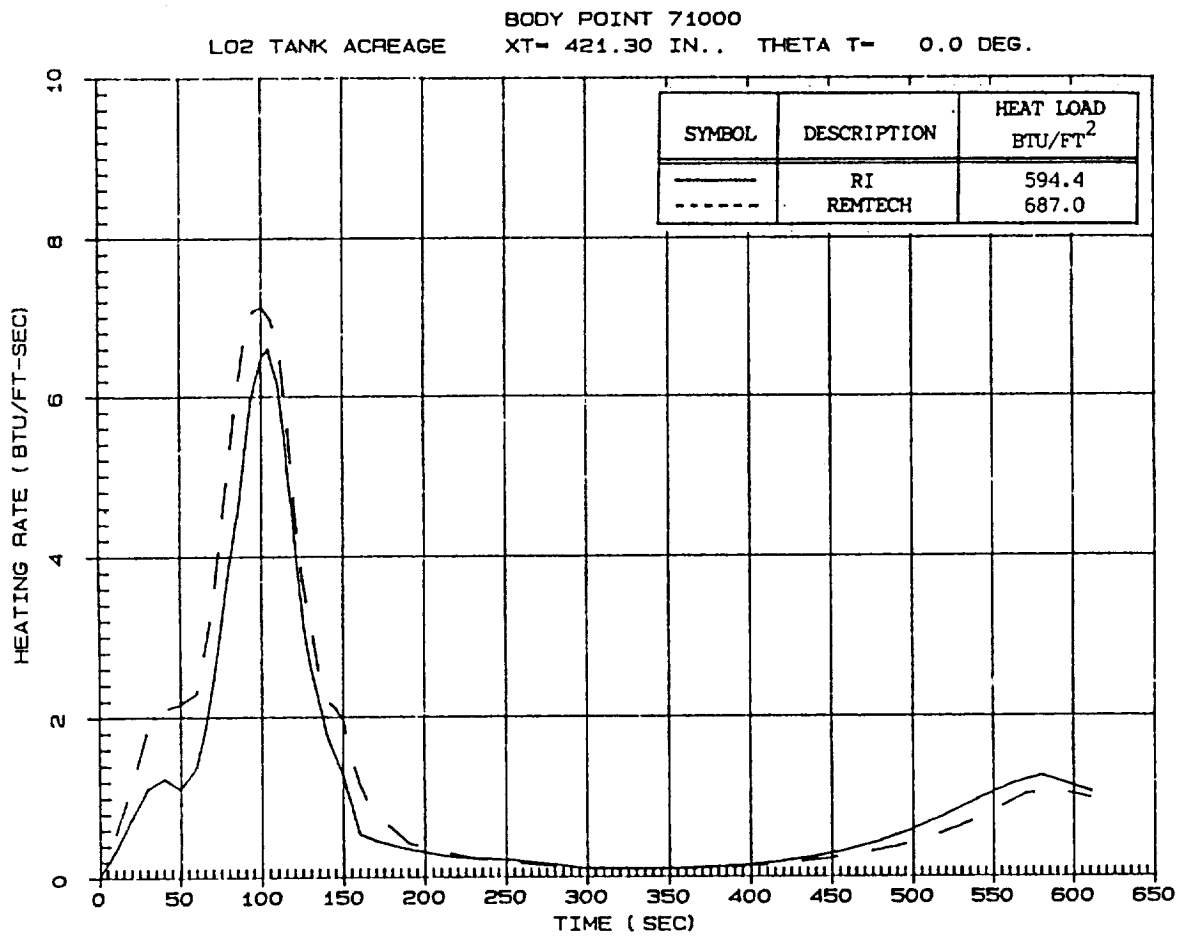
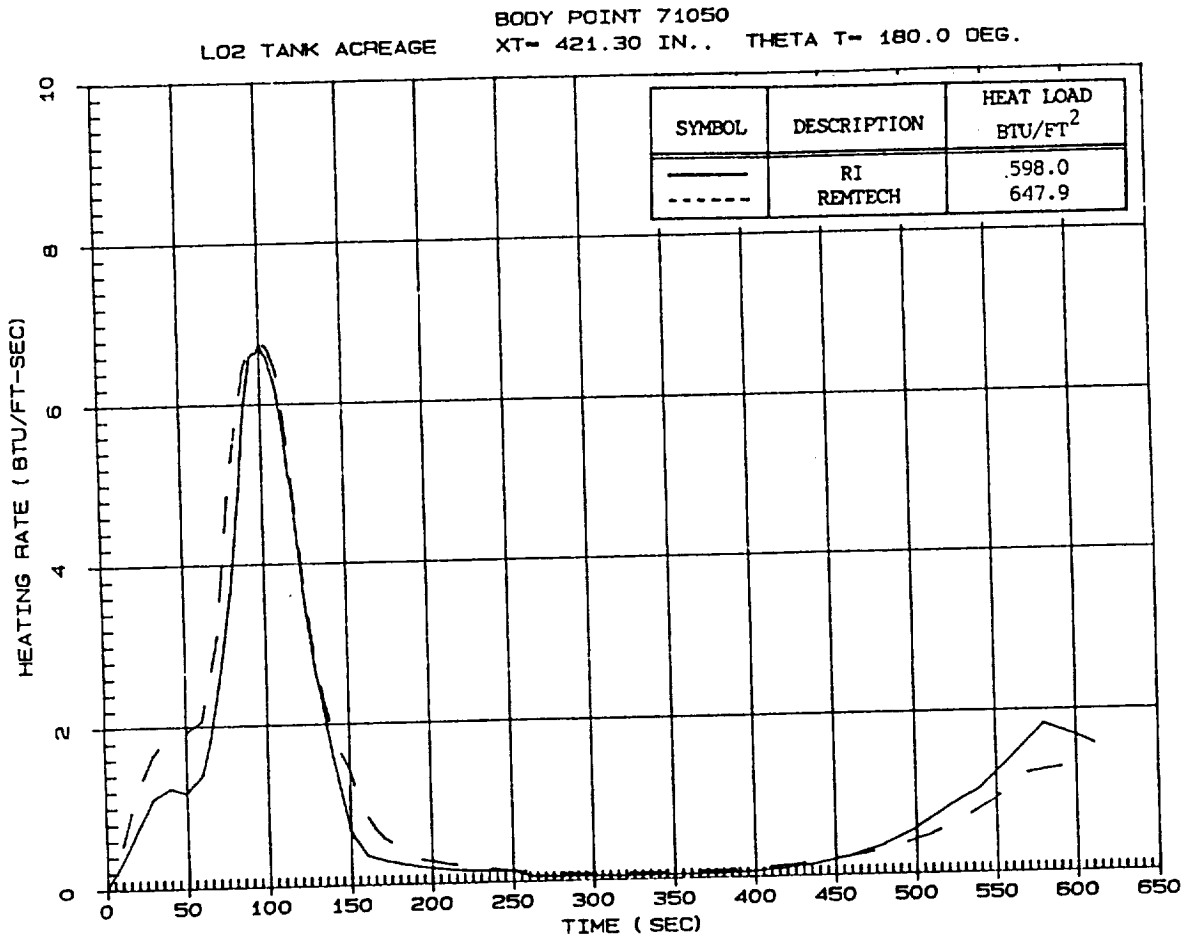


Agreement is acceptable; no TPS impact.



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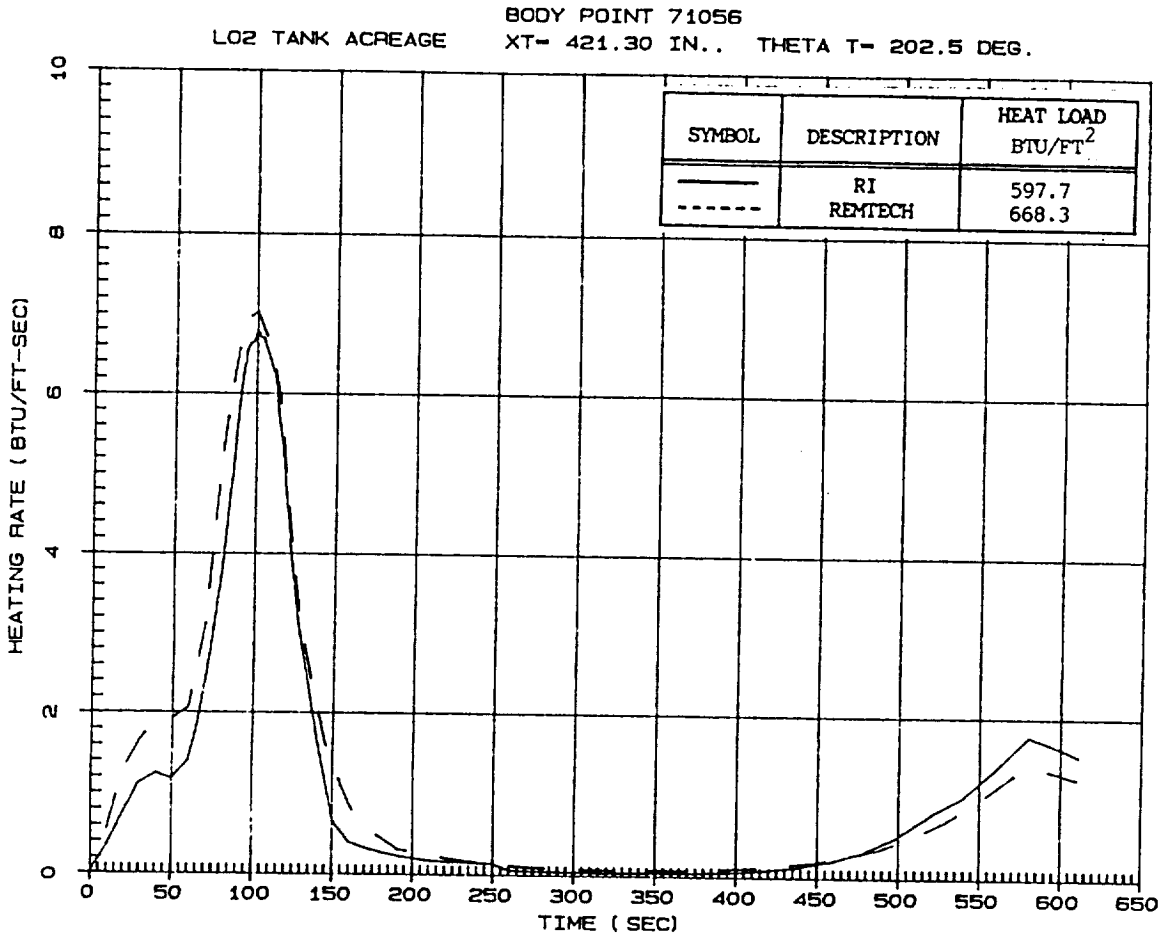

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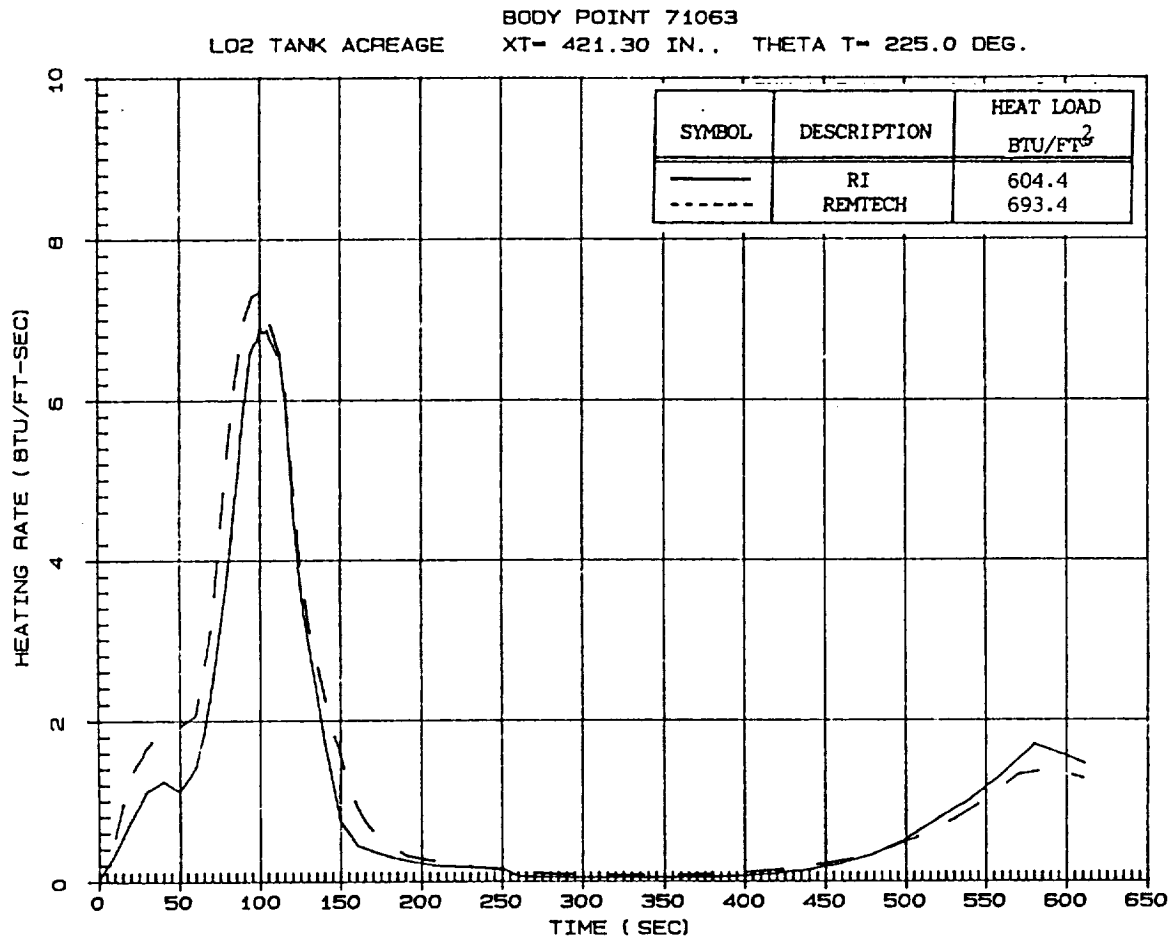

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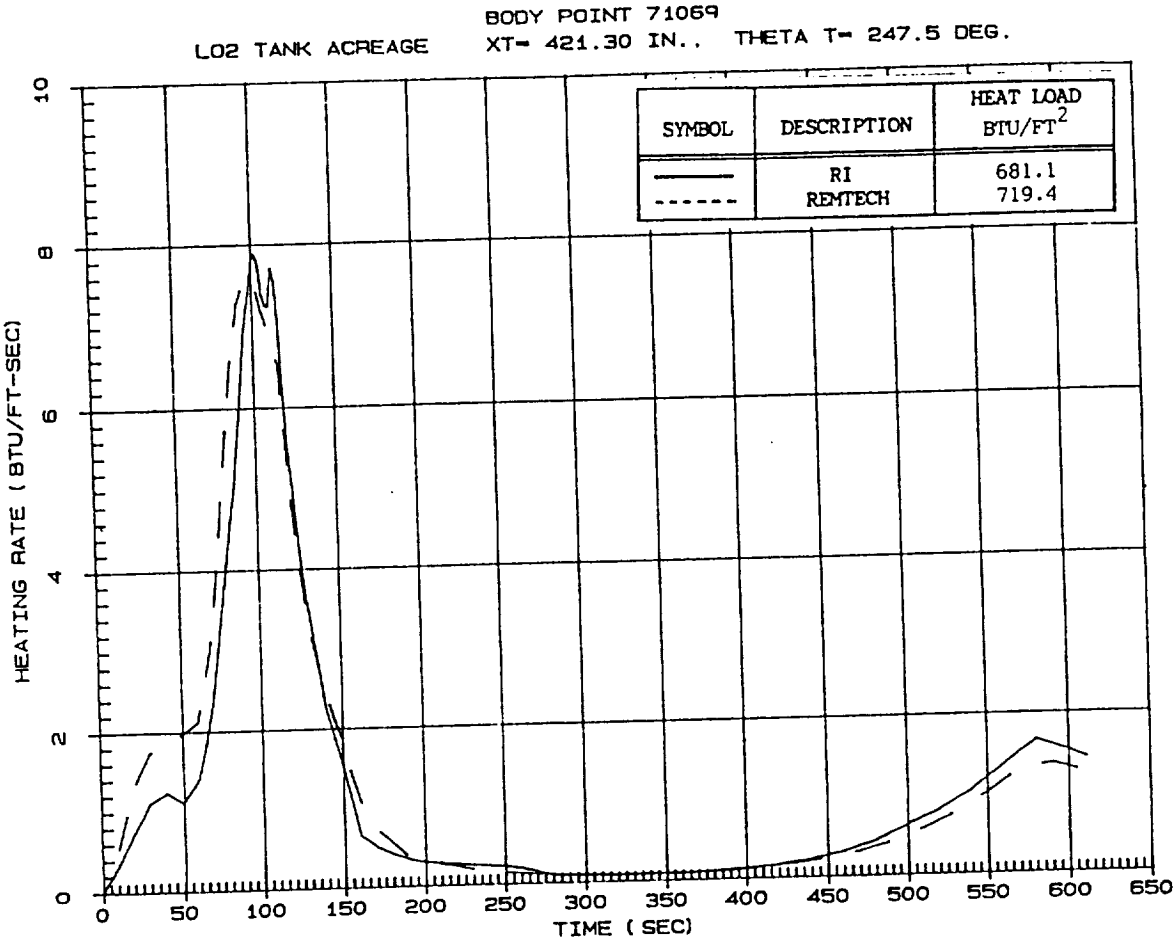

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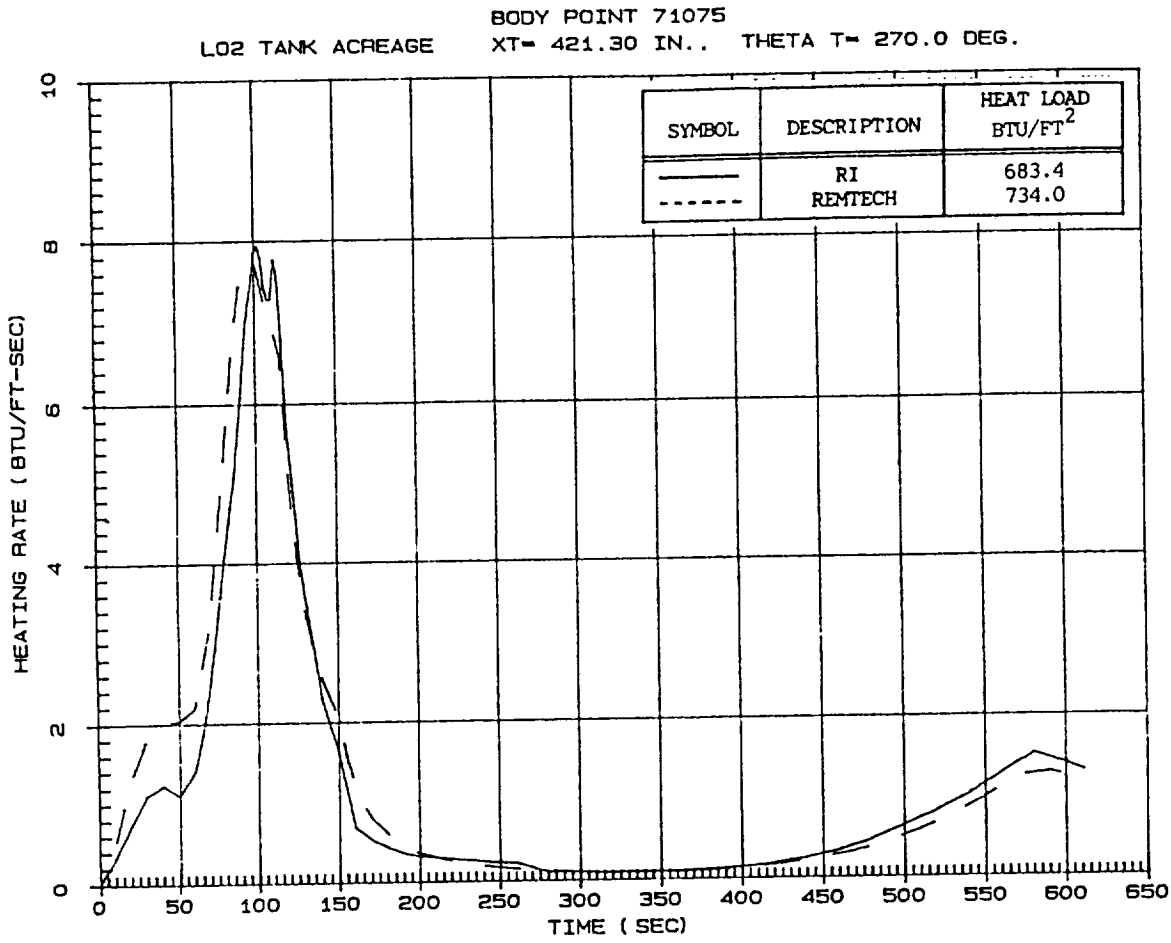

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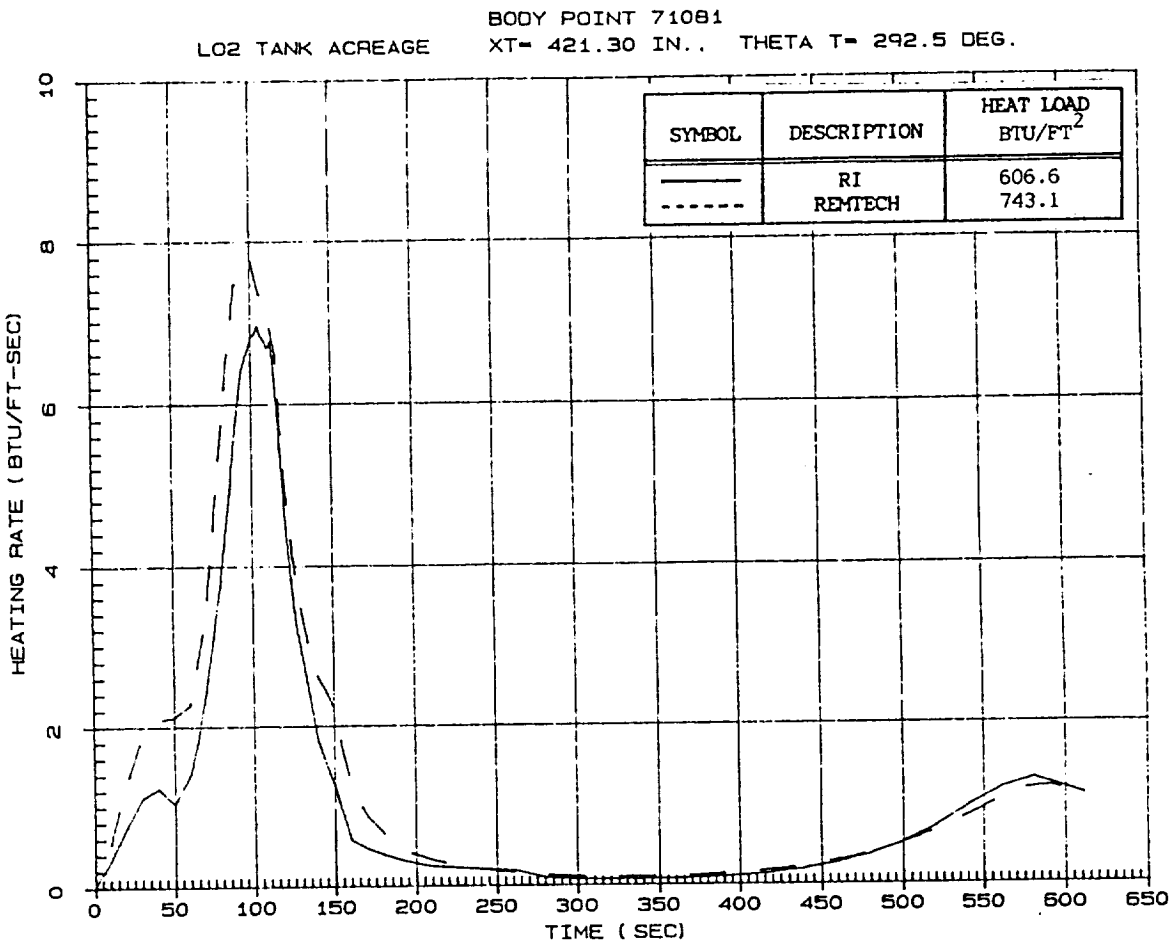

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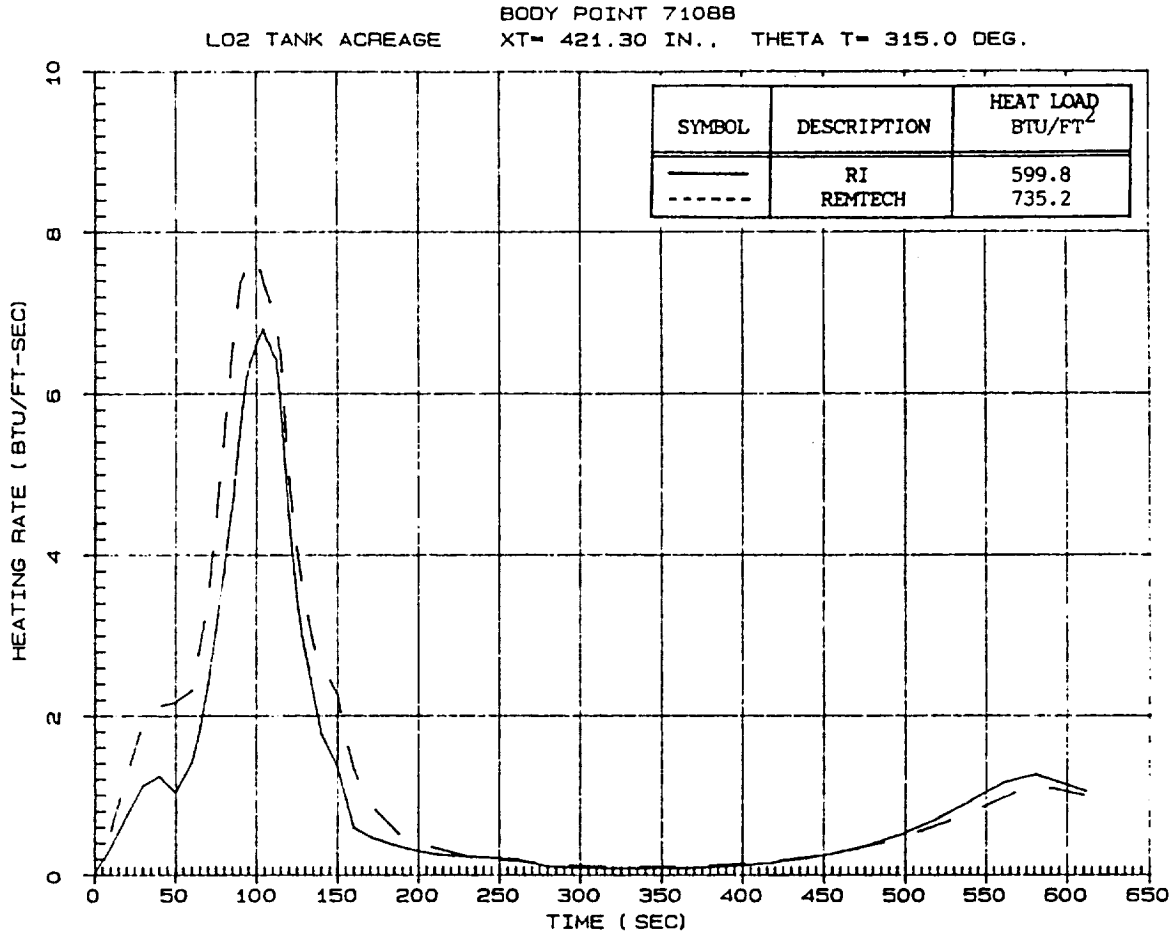

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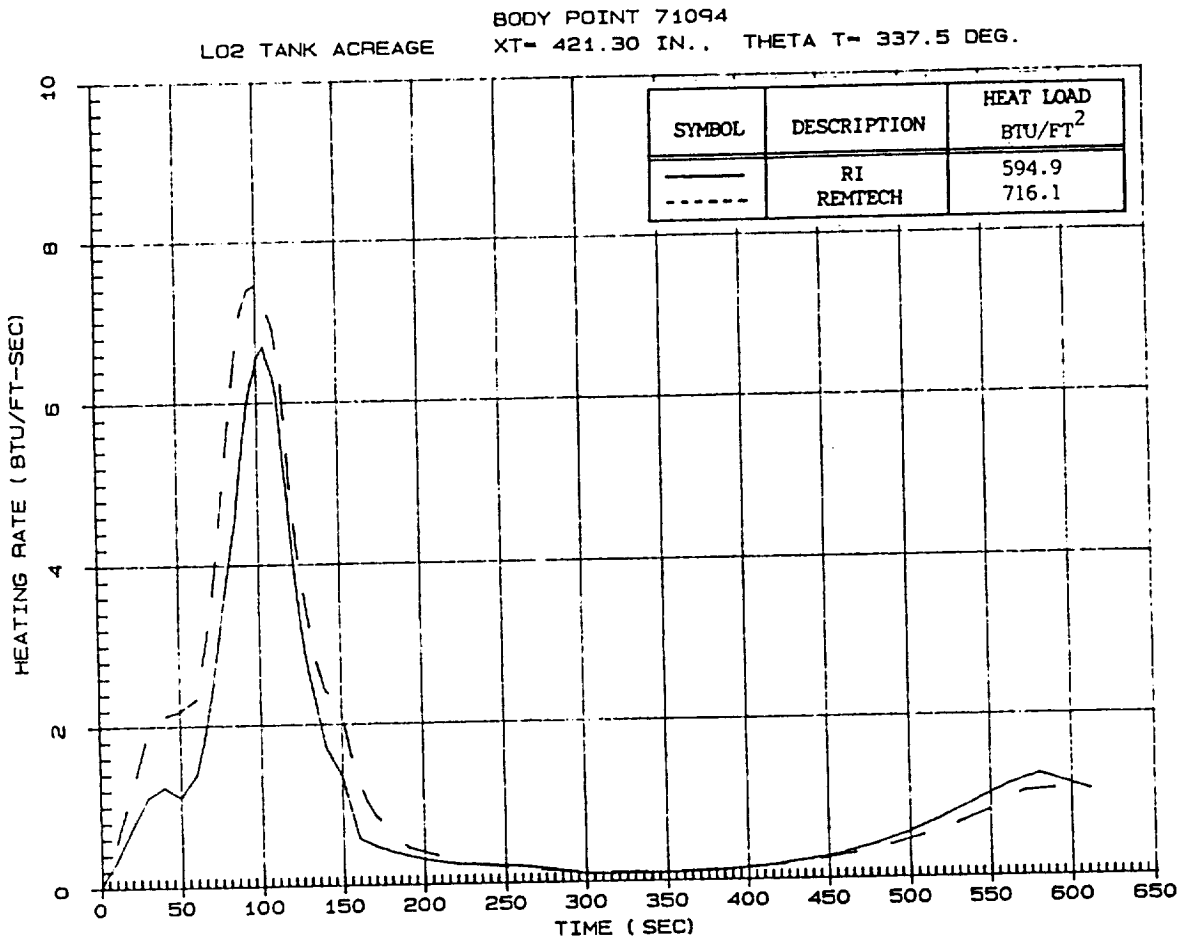

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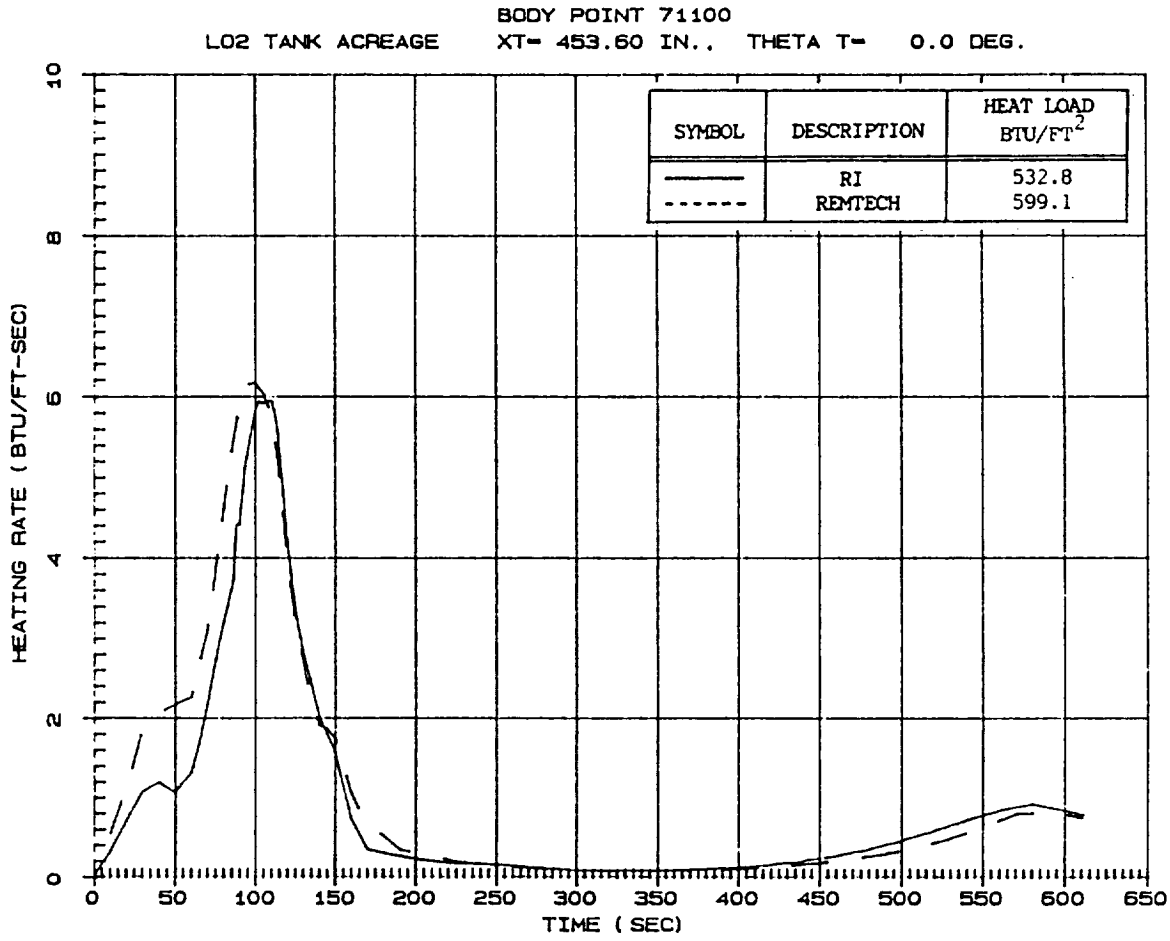

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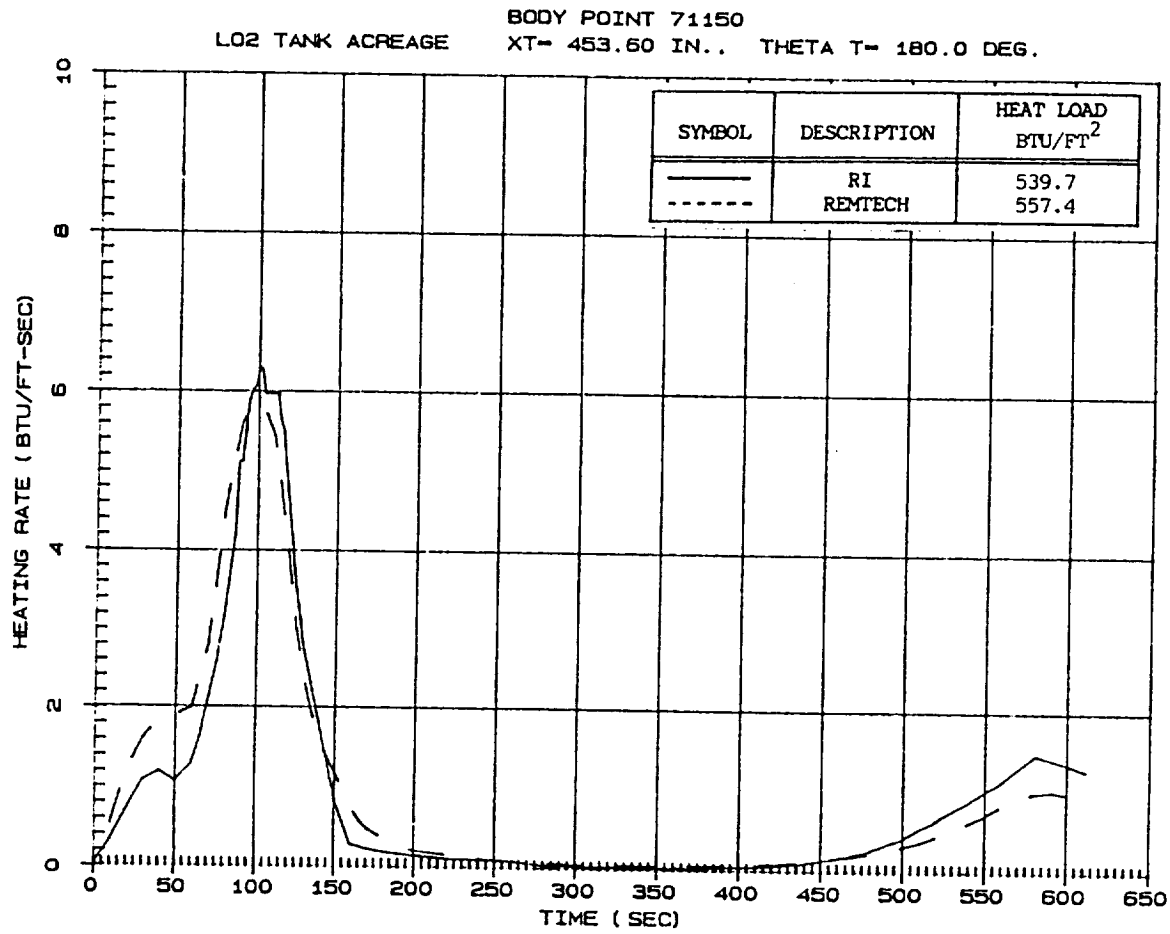

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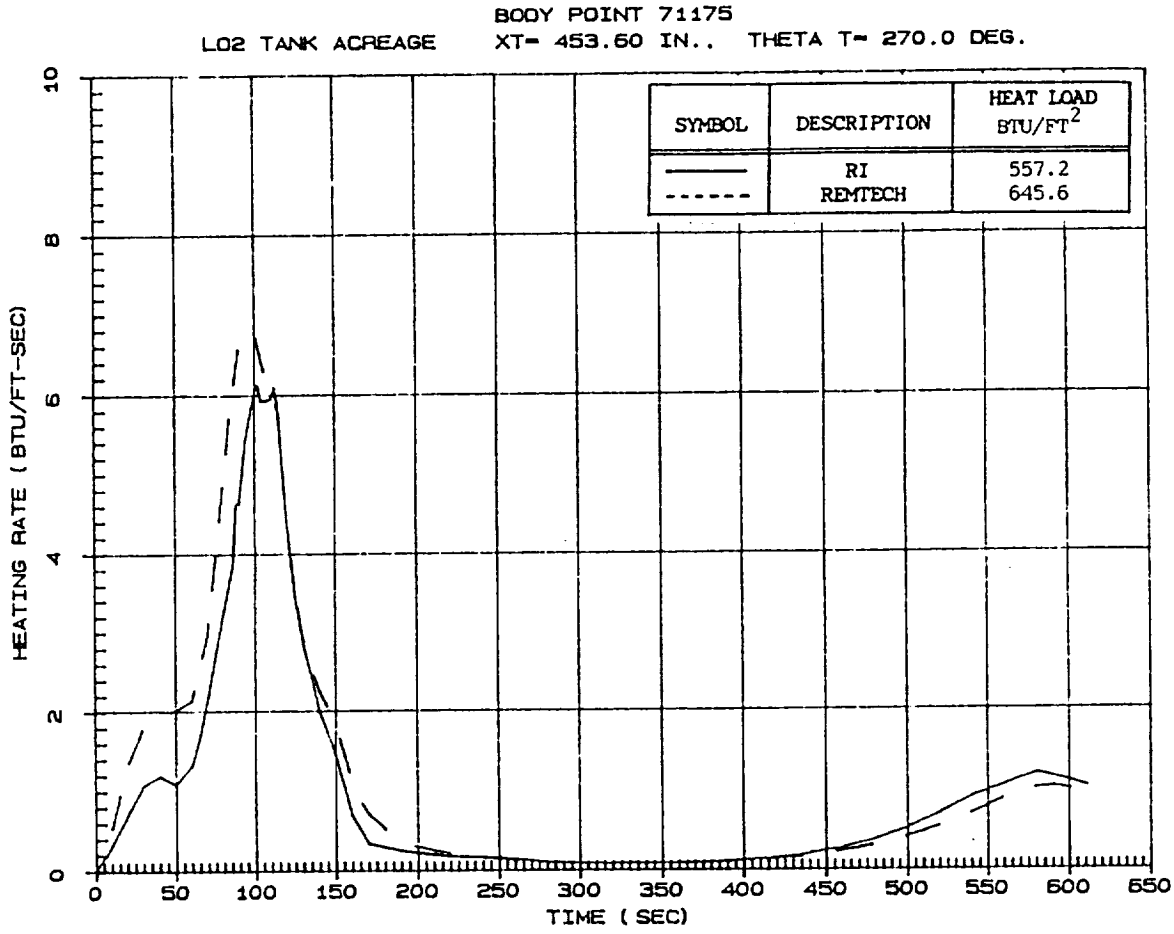

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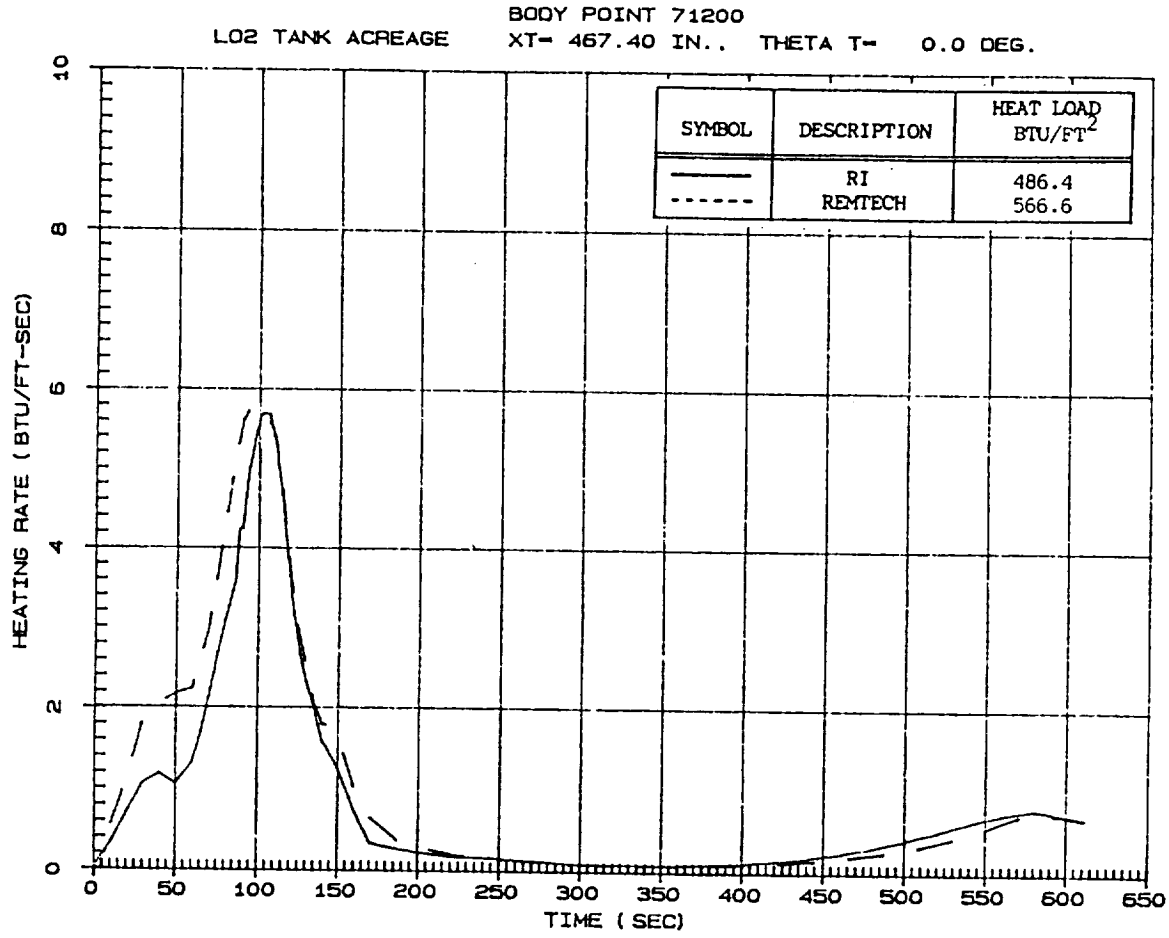

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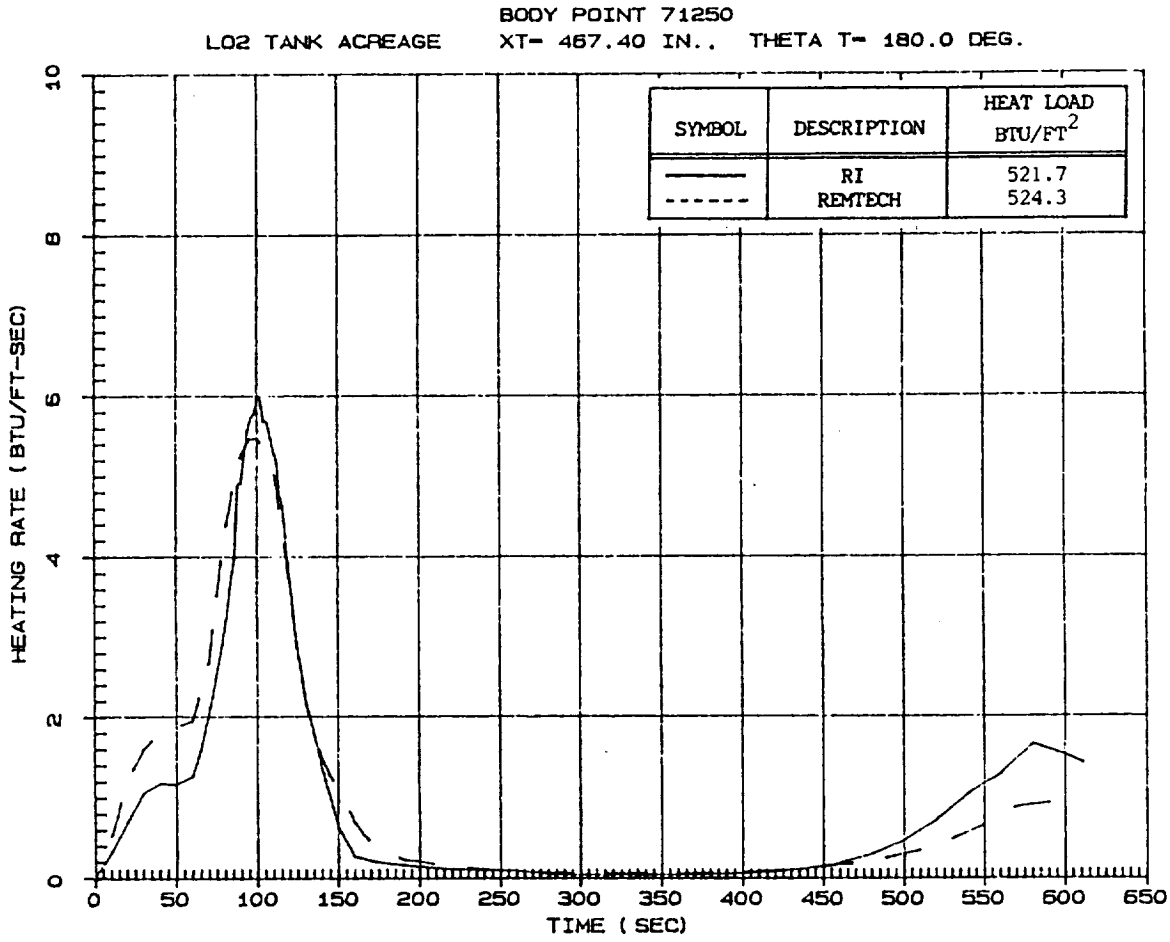

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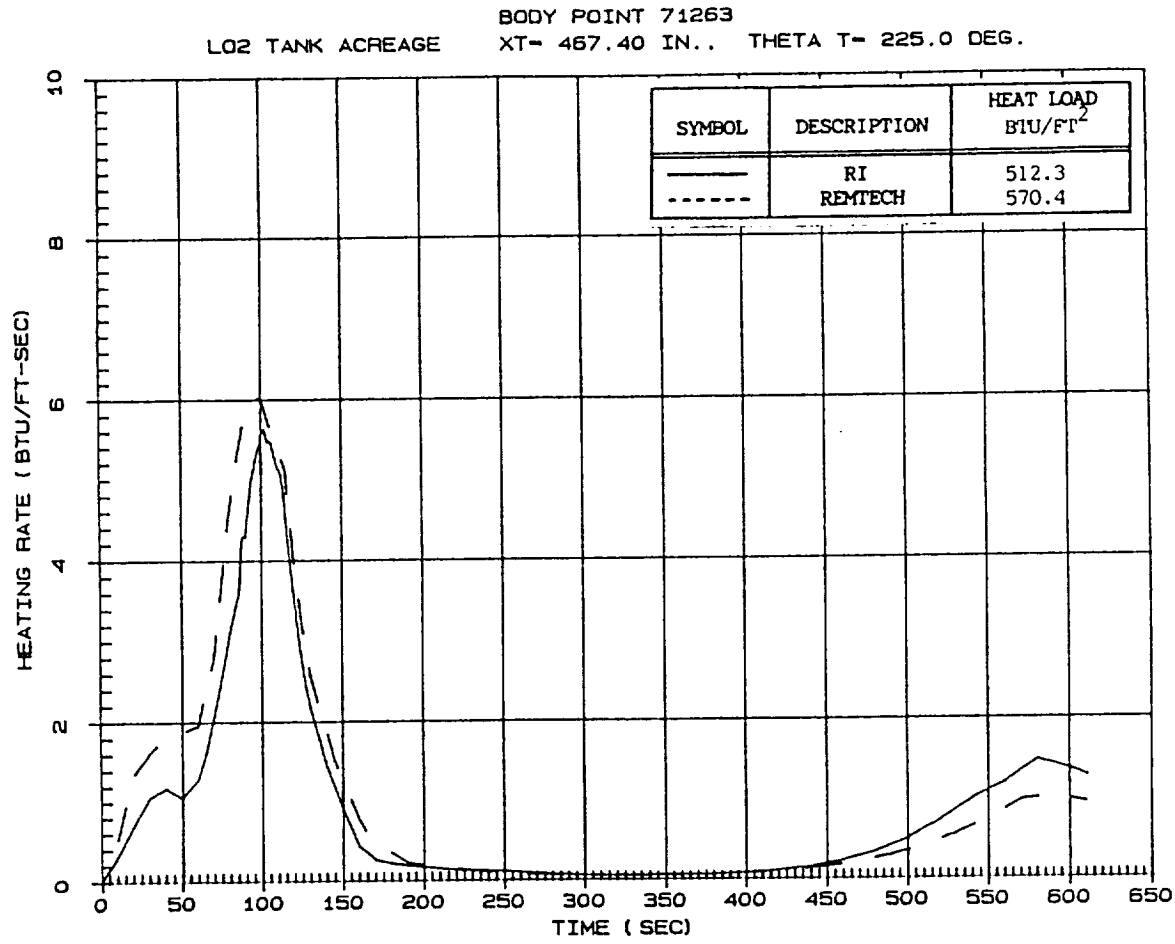

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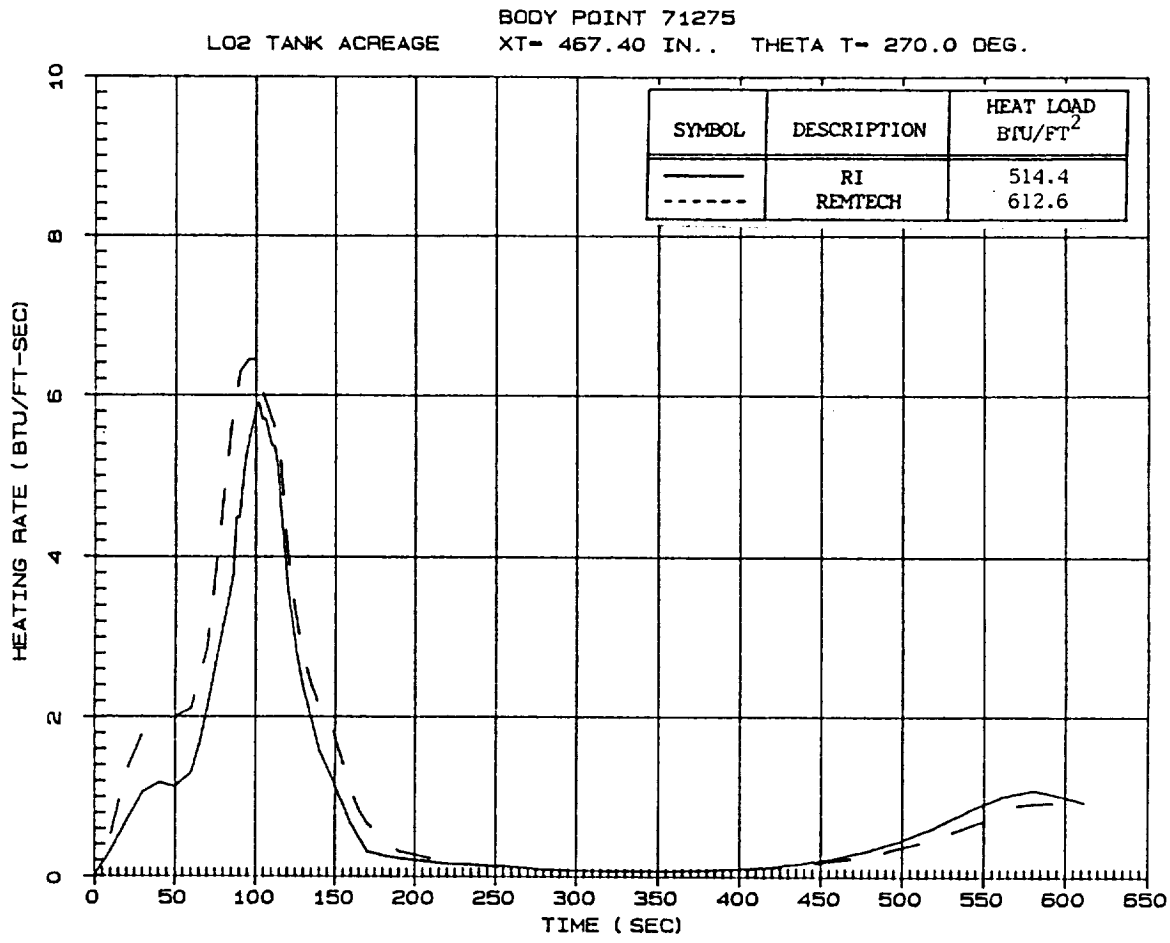

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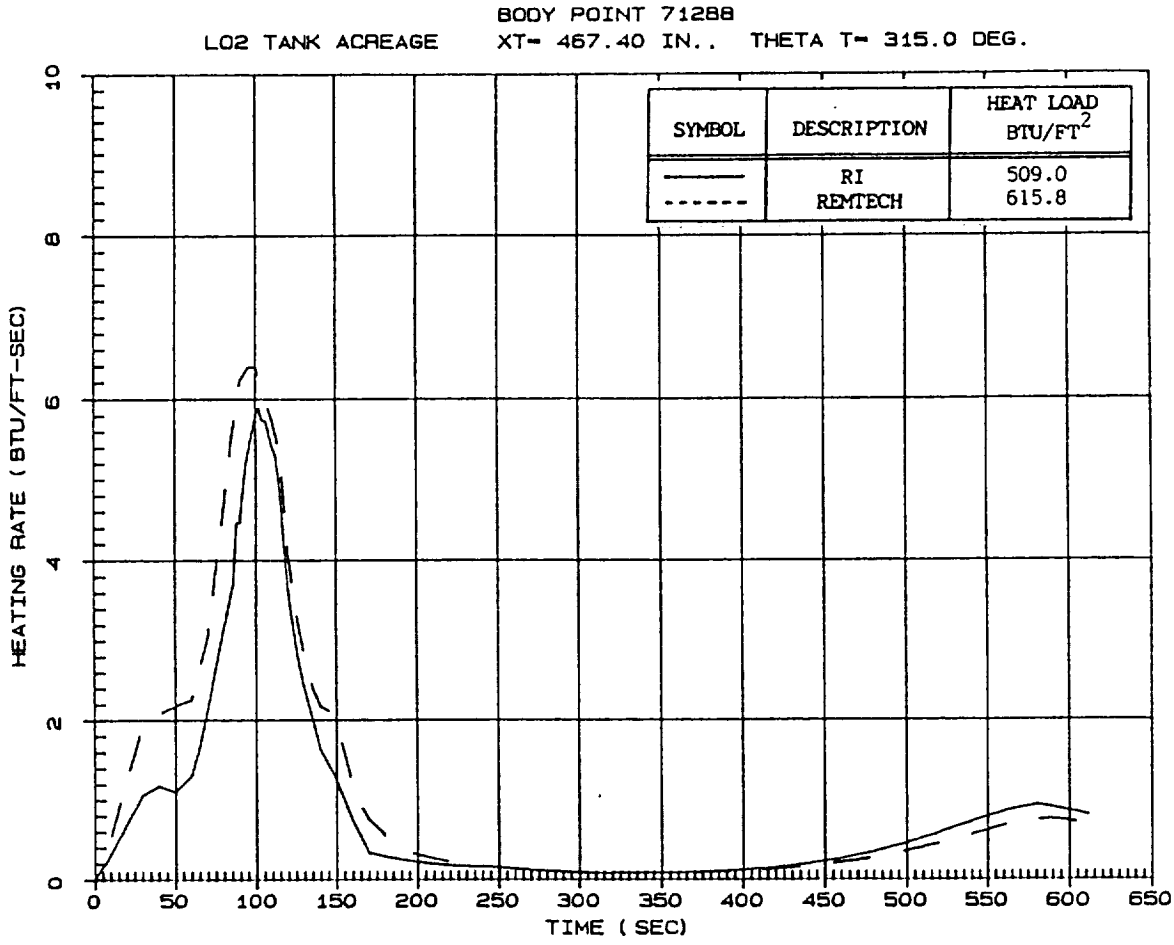

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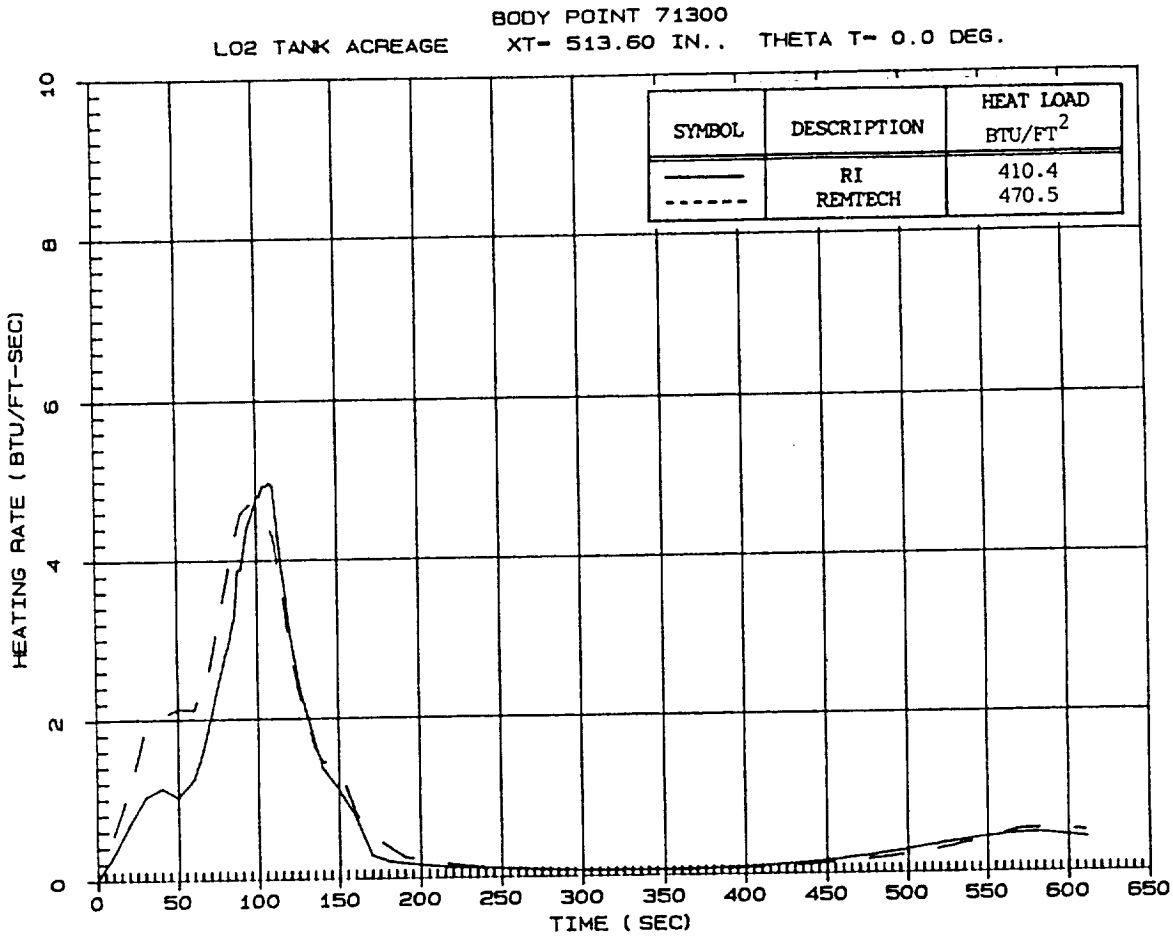

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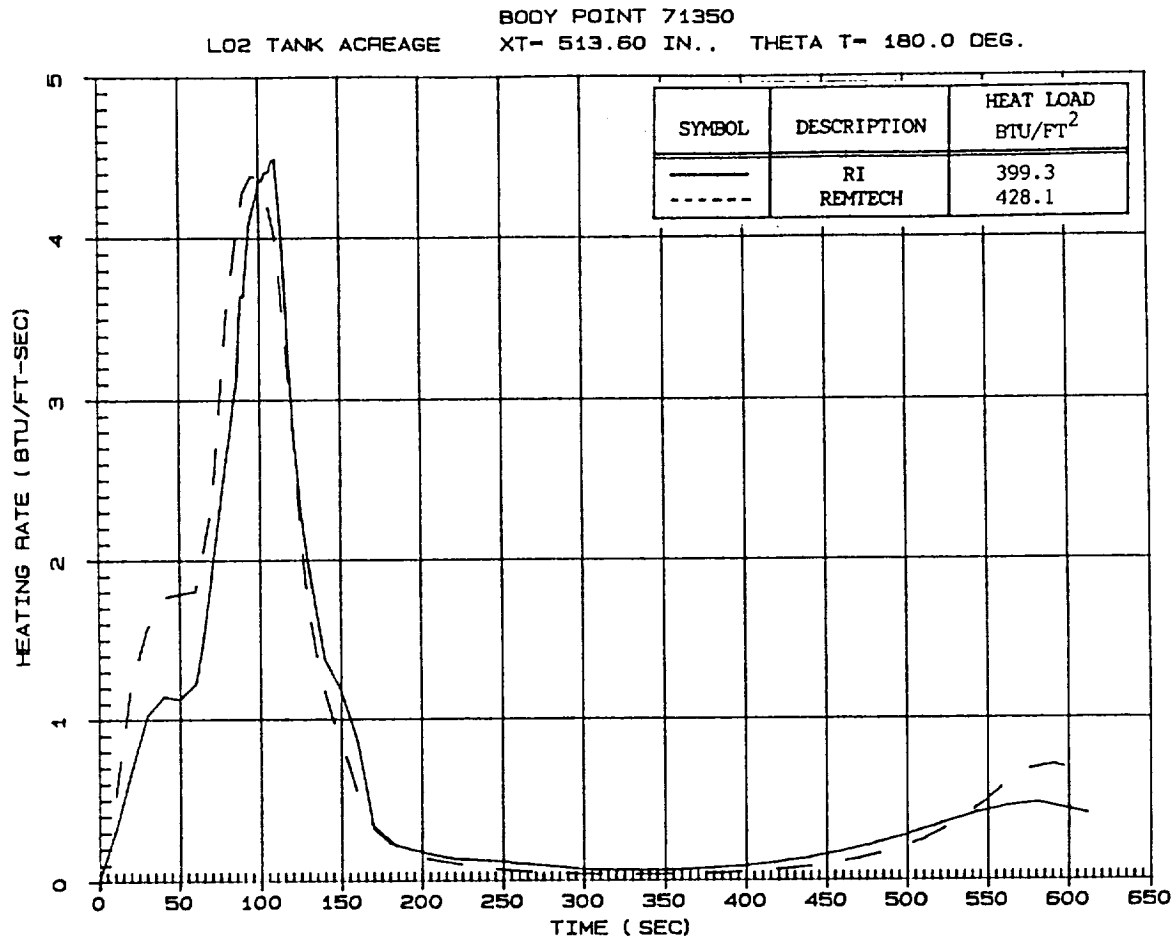

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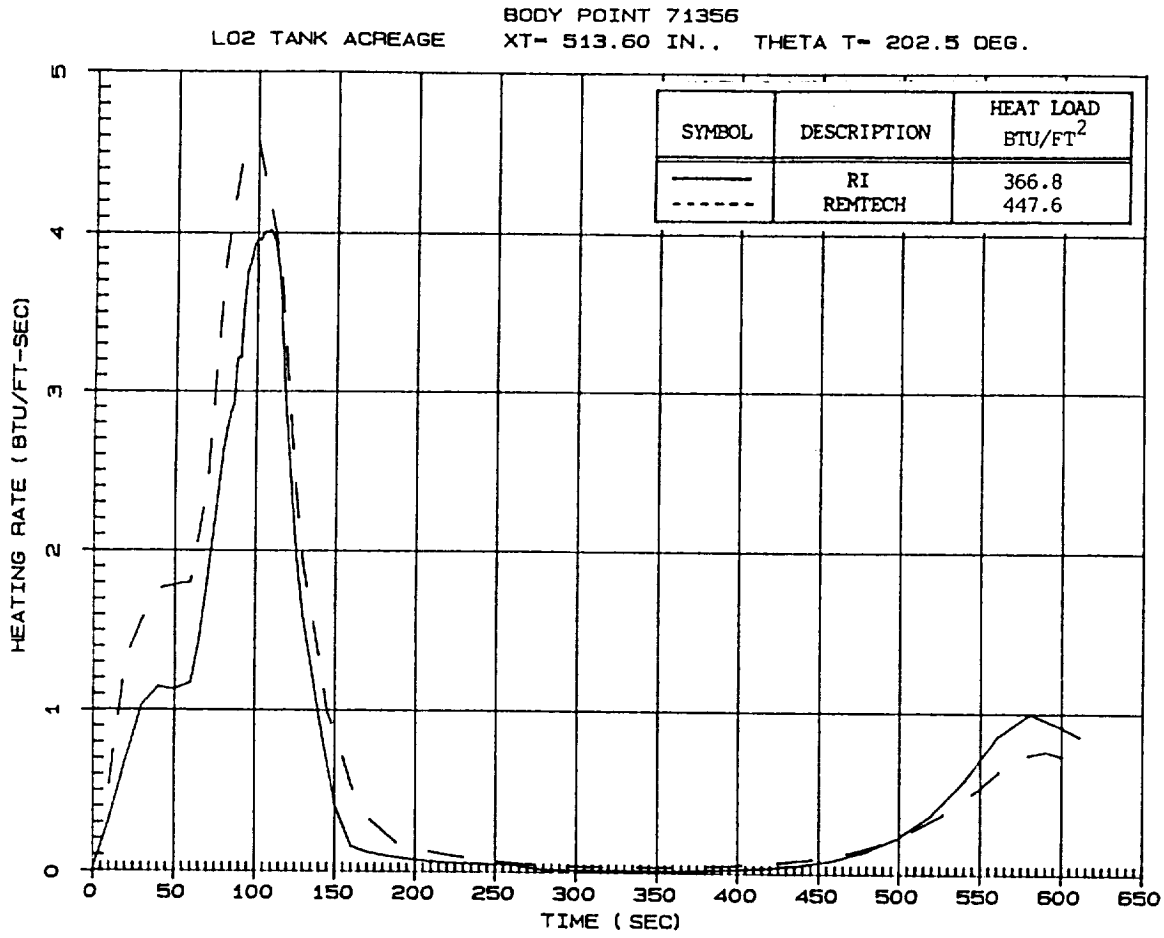

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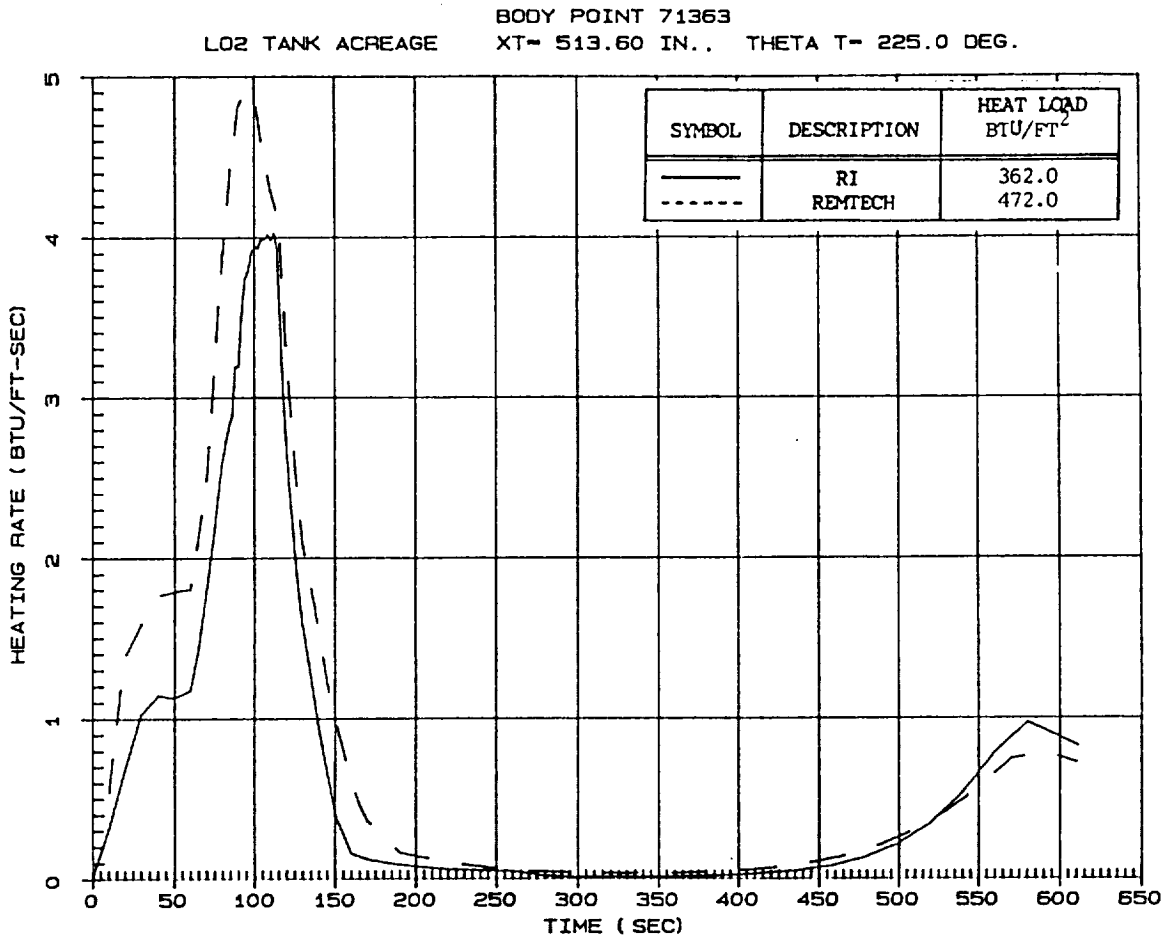
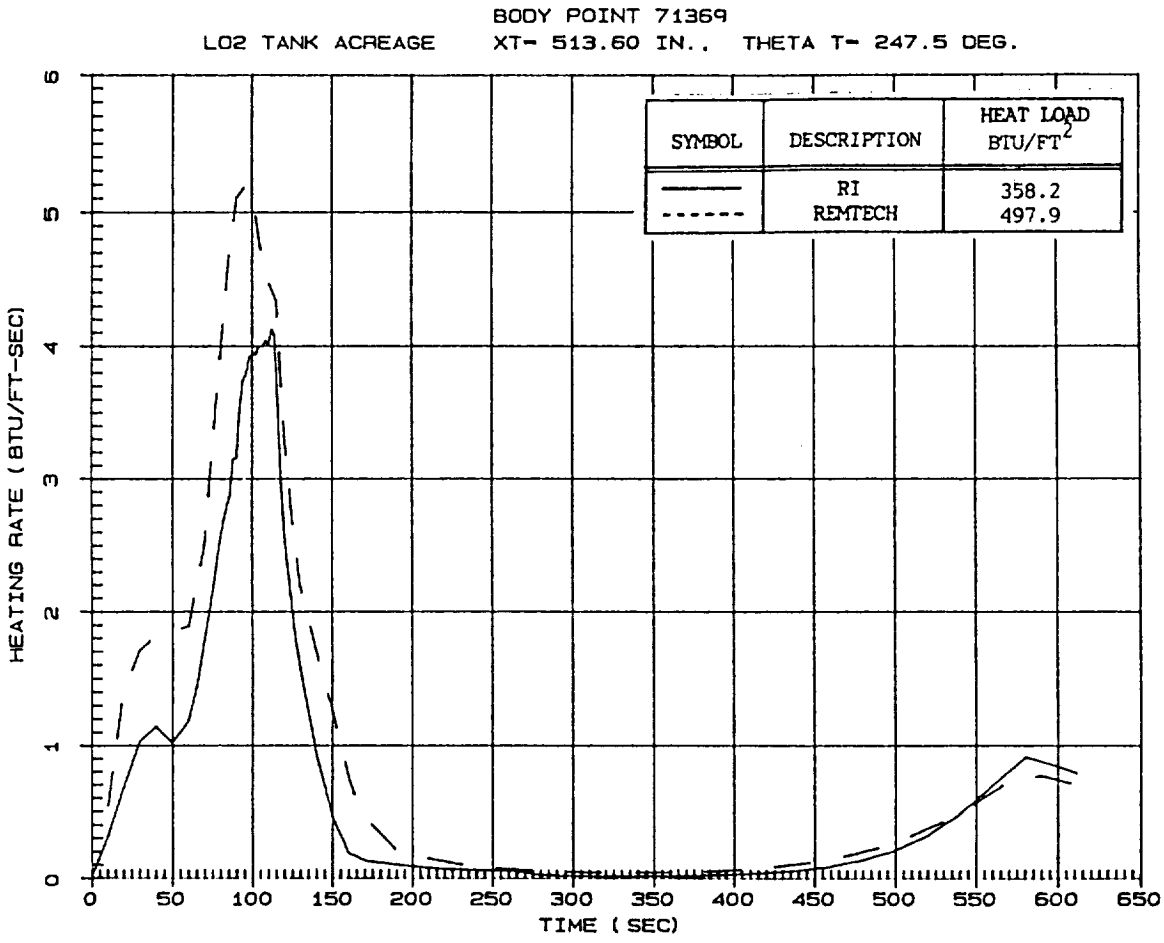


- The difference in max heating rate amounts to ~0.1 inches of TPS, well within the allowable application uncertainty of ± 0.38 inches of CPR.

Agreement is acceptable; no TPS impact.



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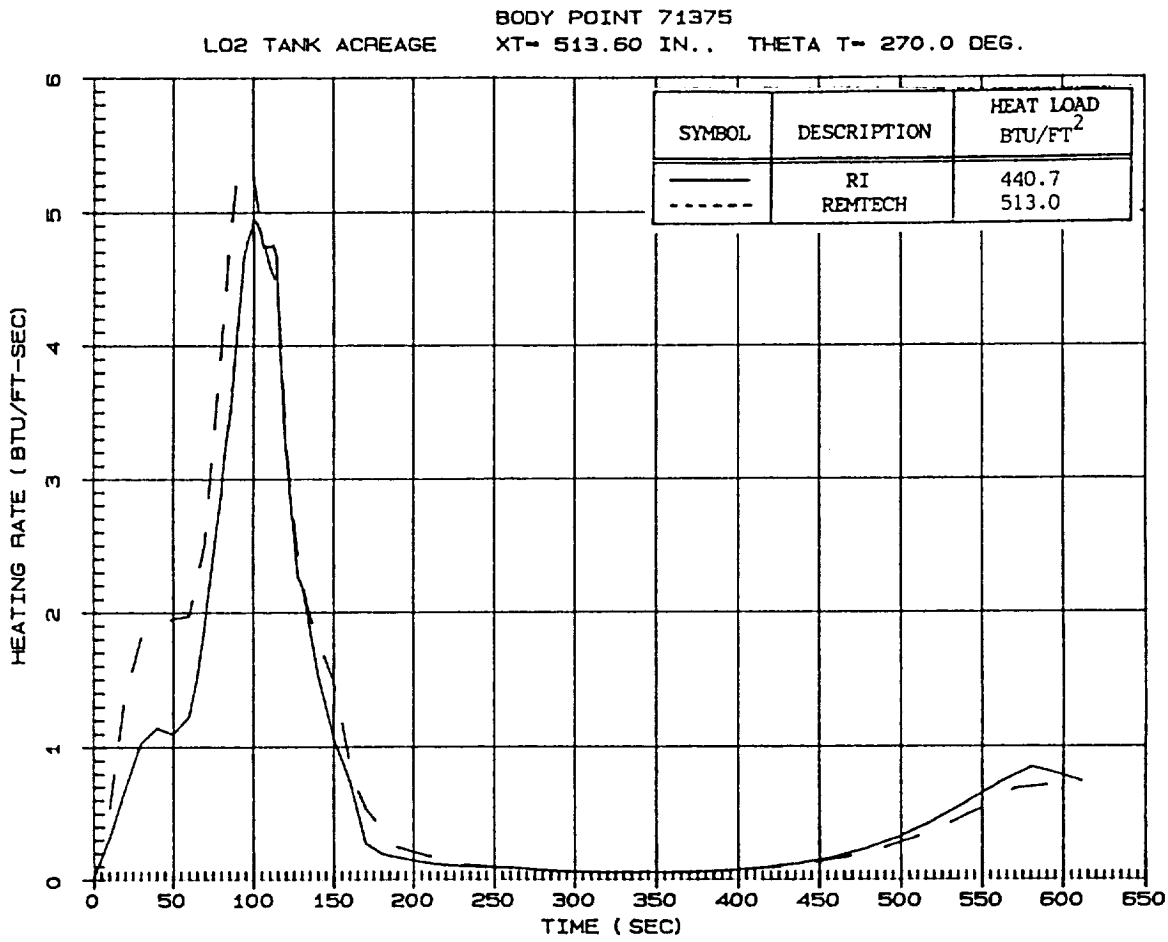

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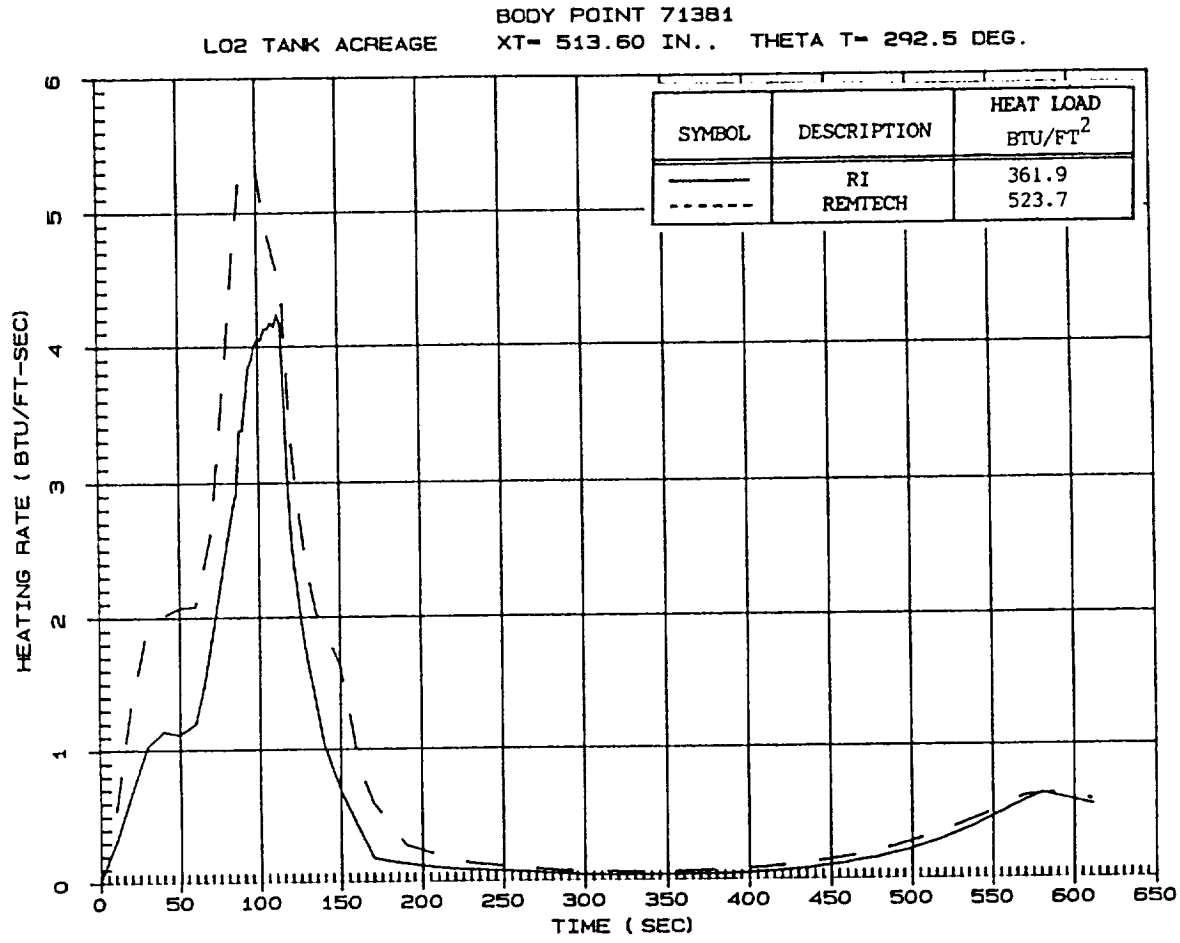

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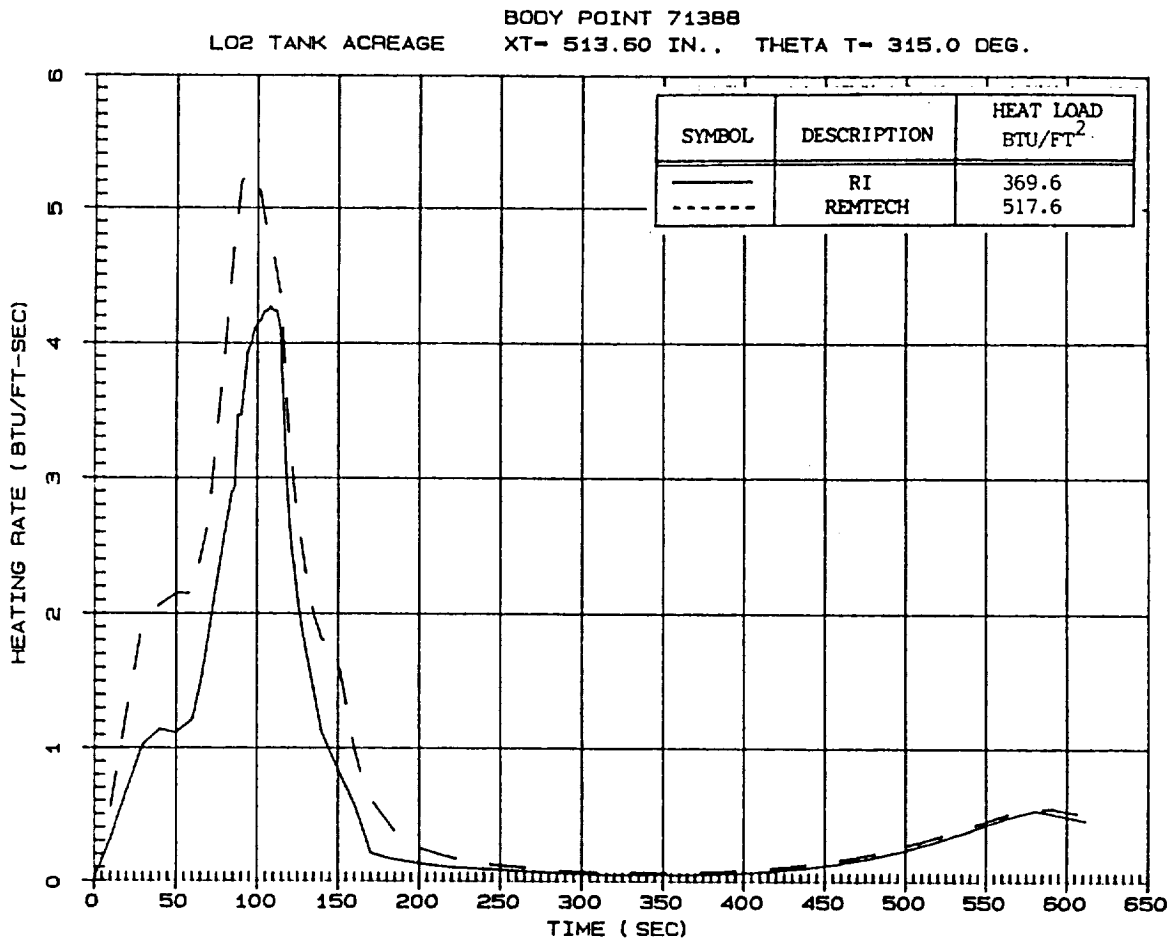

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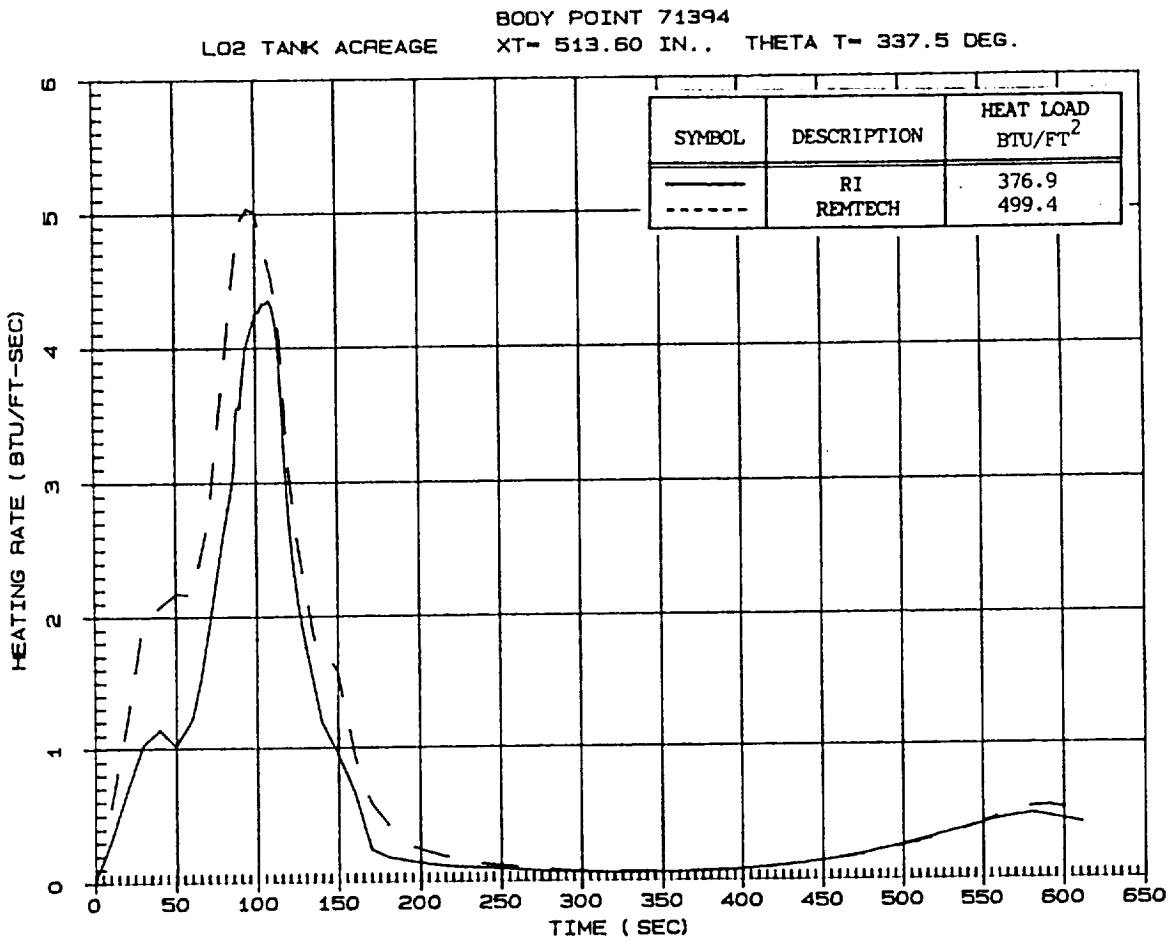
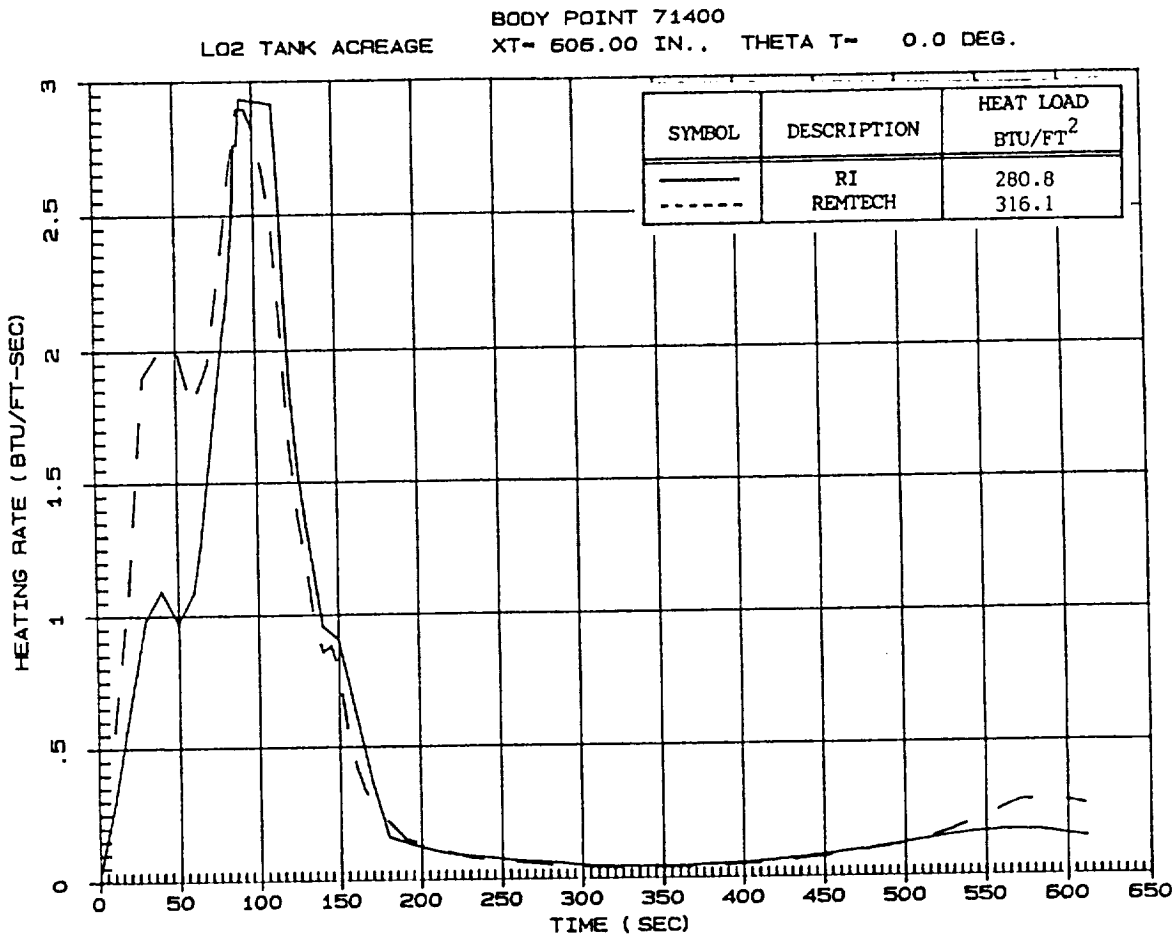


- The difference in max heating rate amounts to < 0.1 inches of TPS, well within the allowable application uncertainty of $\pm$ 0.38 inches of CPR.

Agreement is acceptable; no TPS impact.



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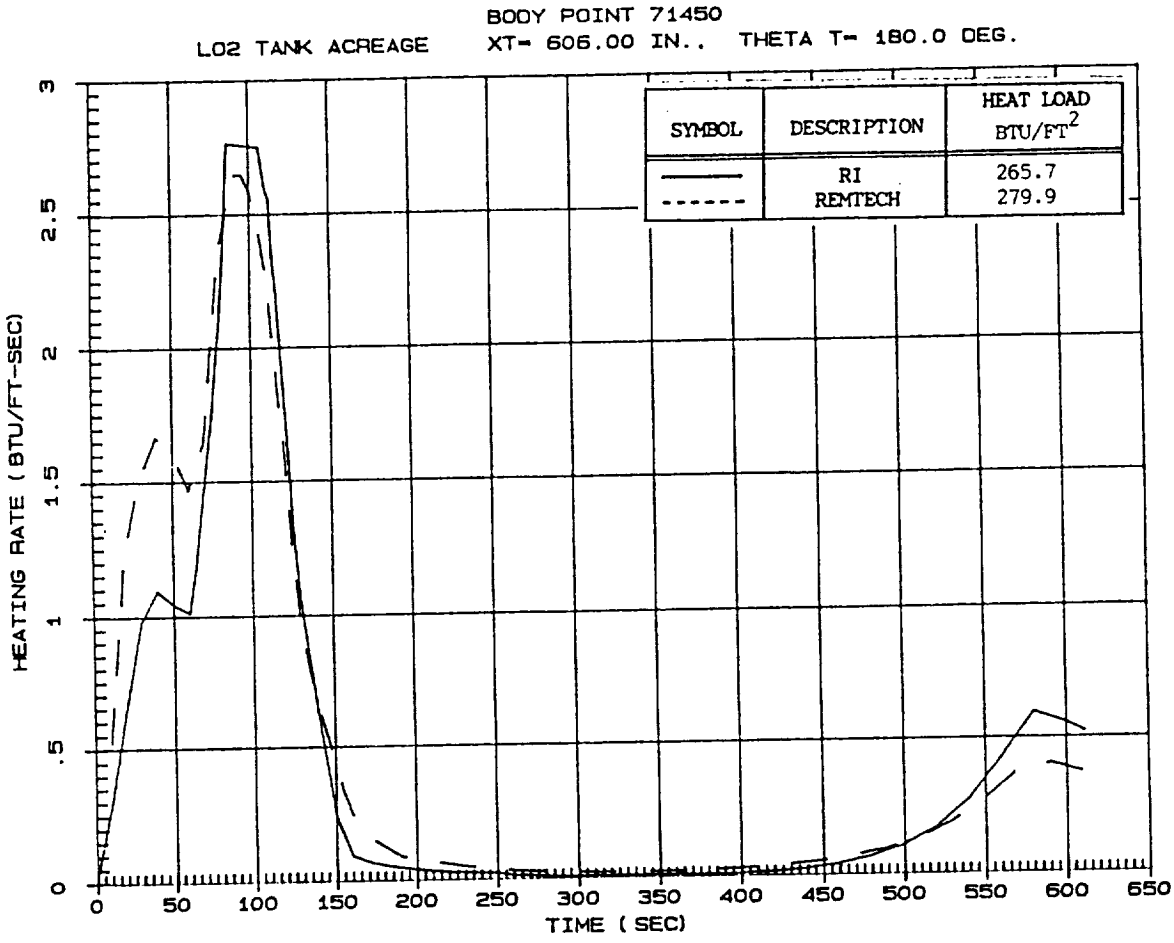

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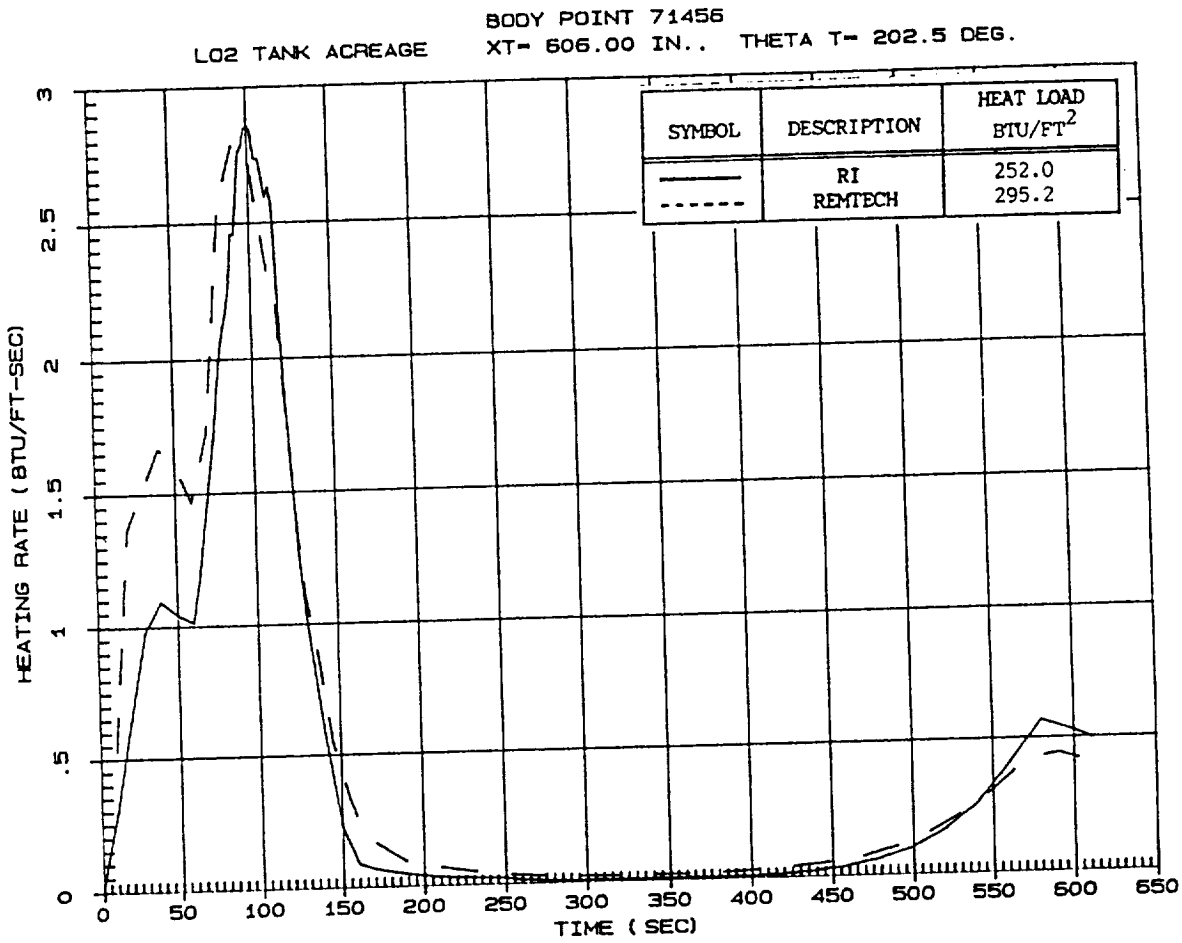

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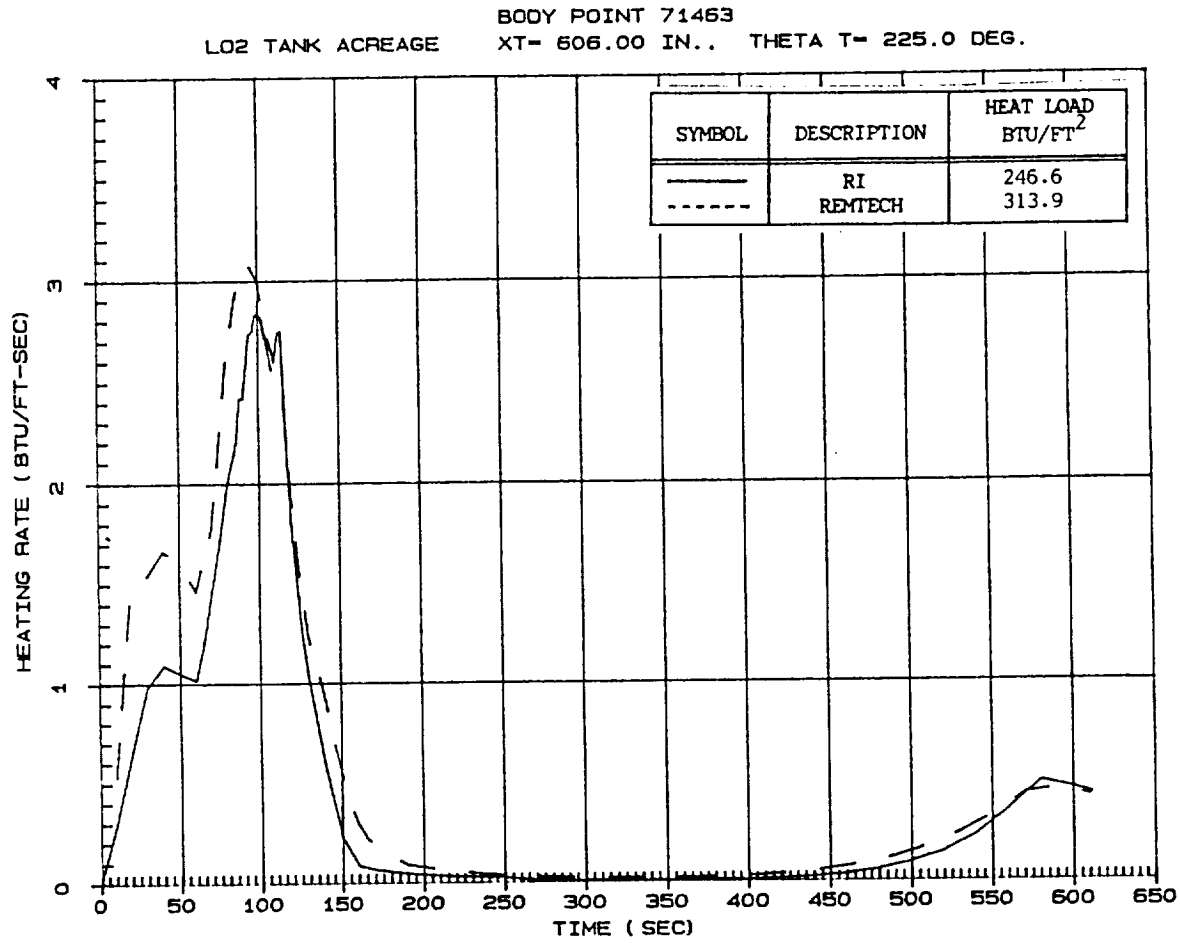

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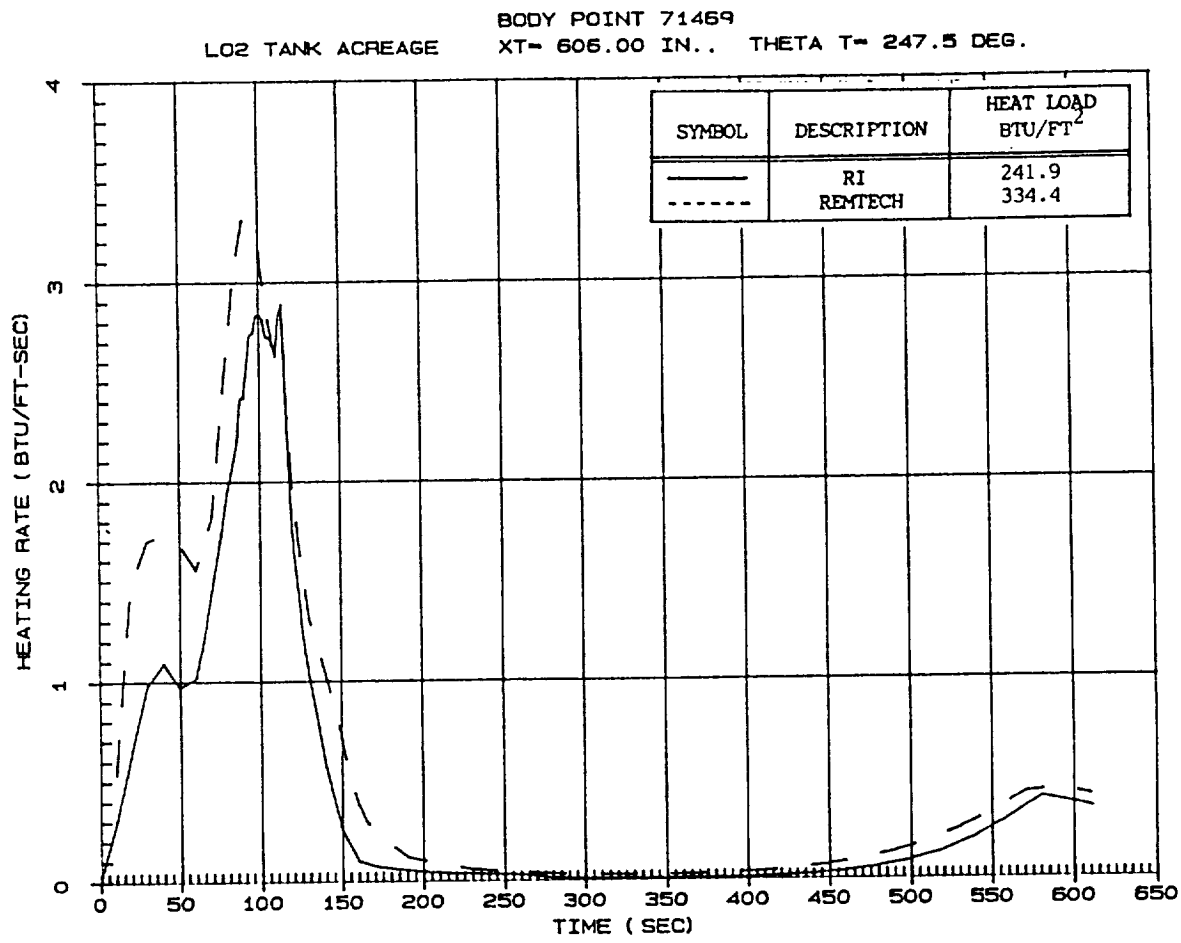

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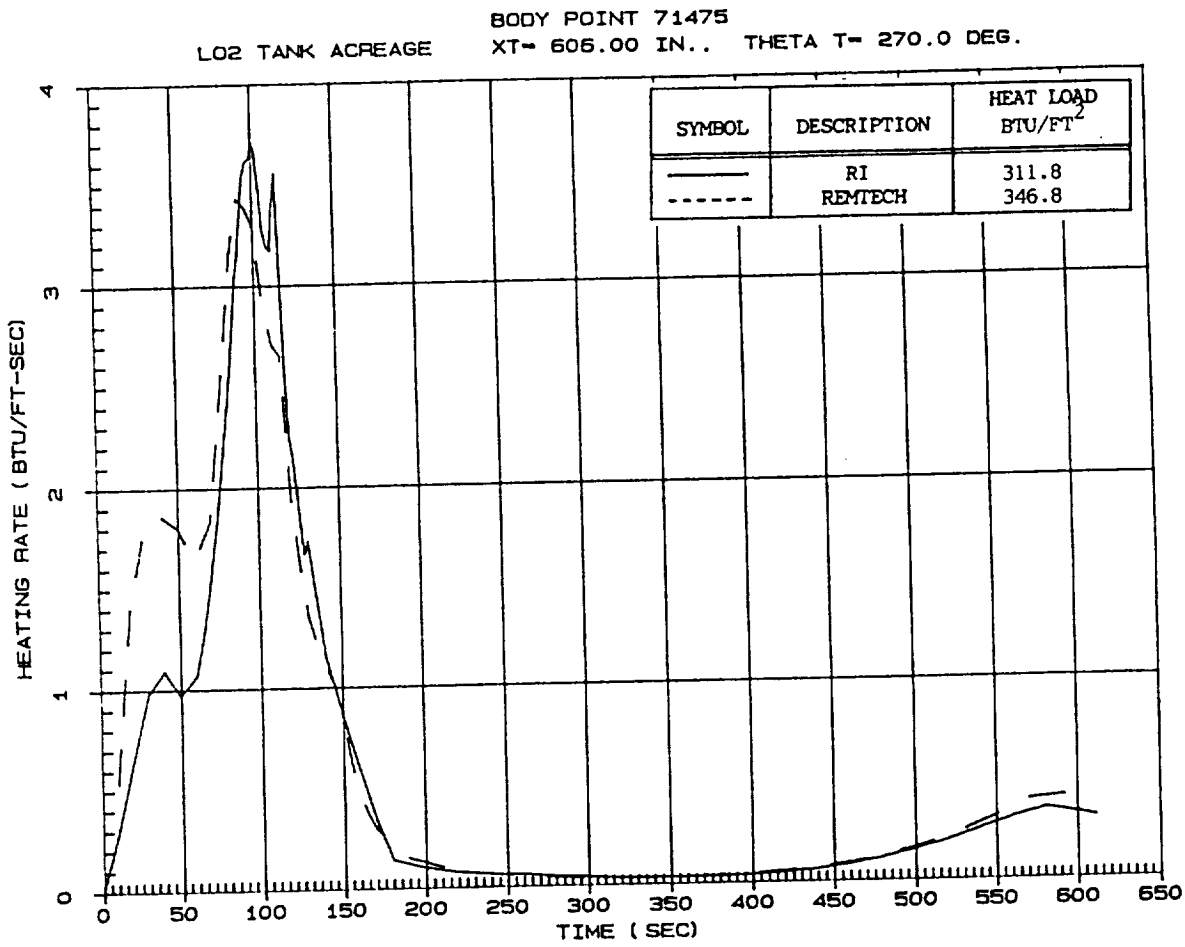

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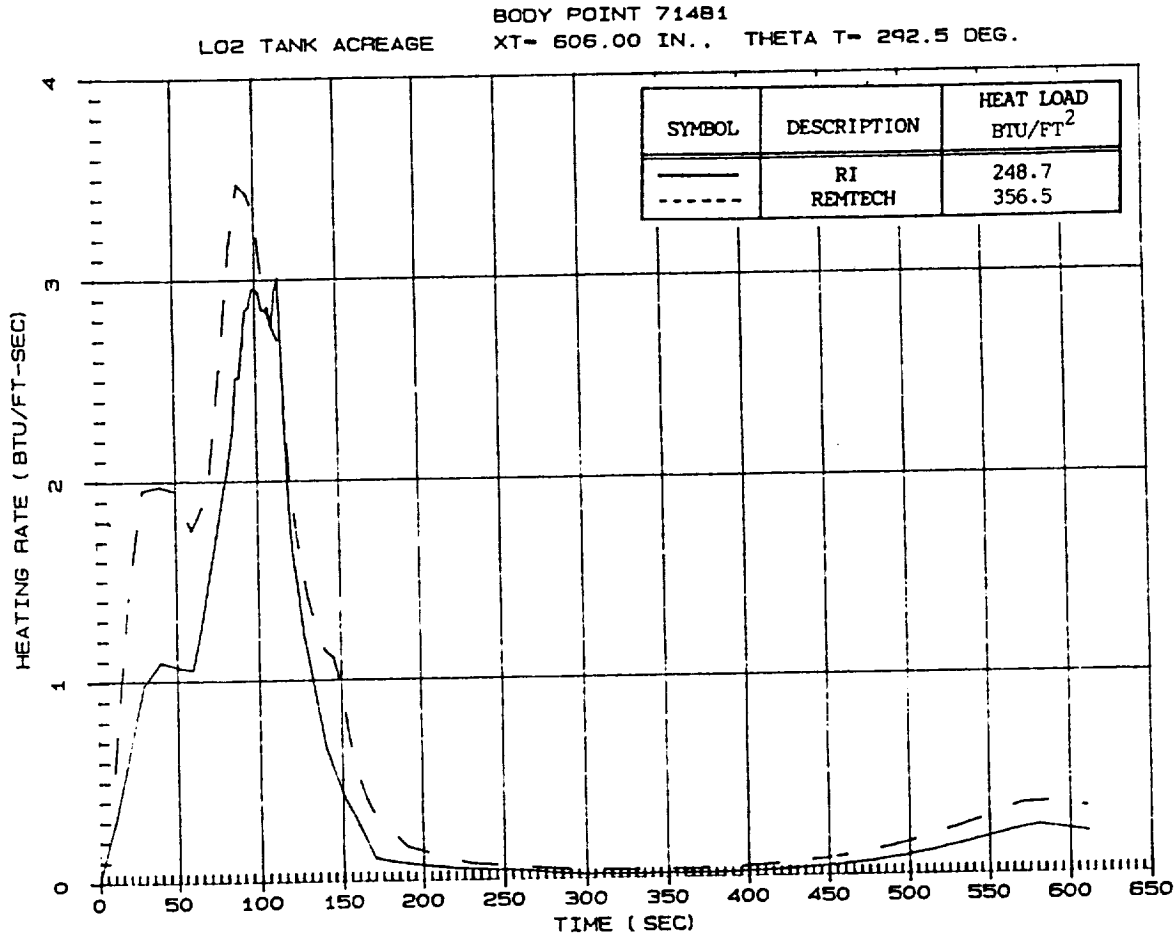

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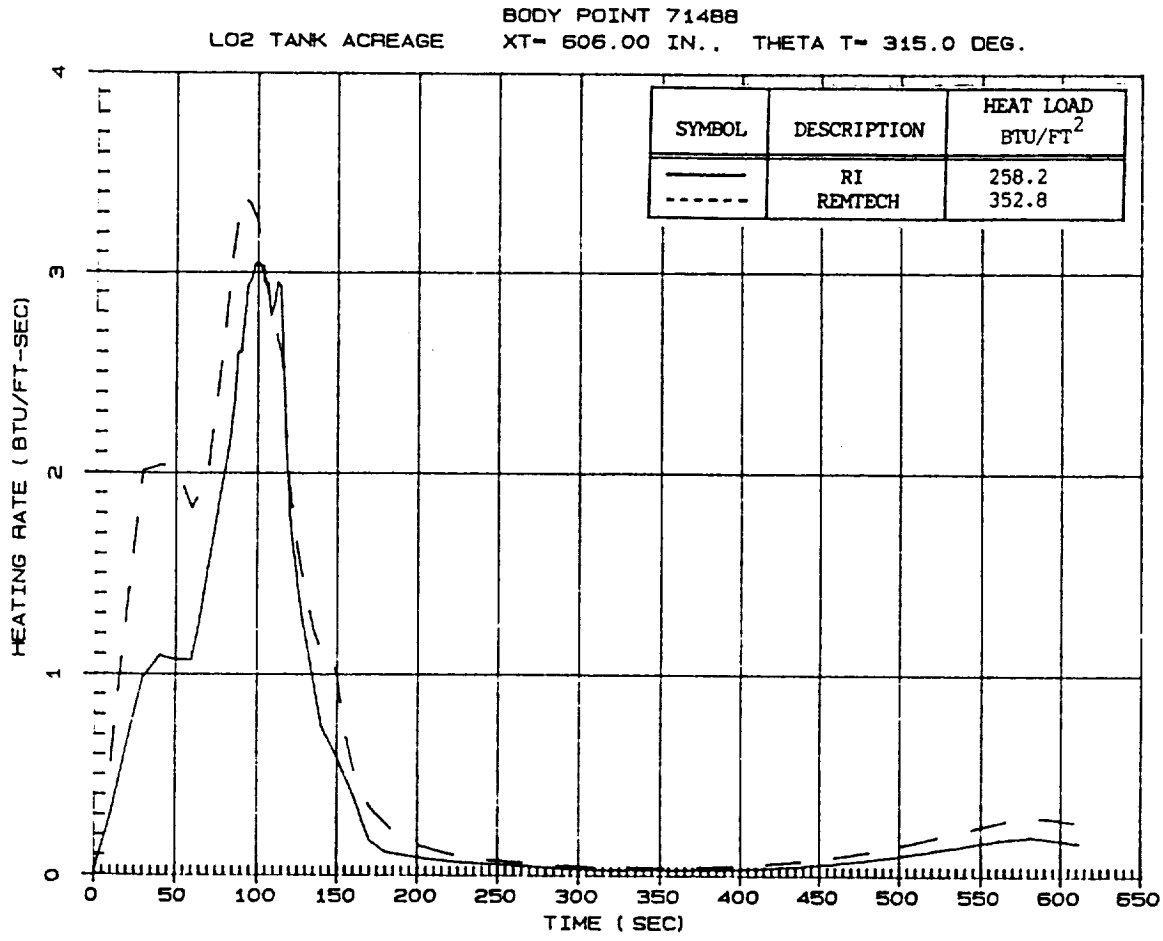

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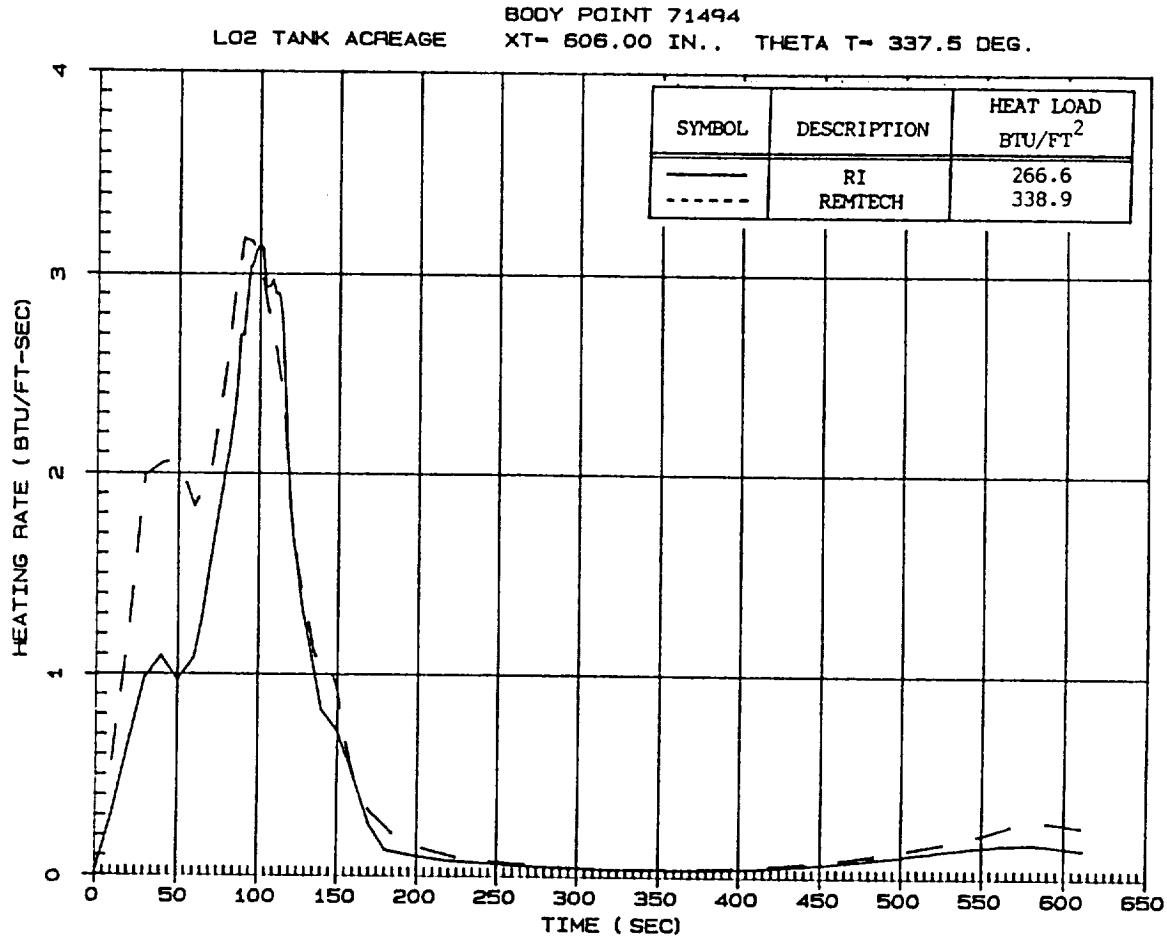

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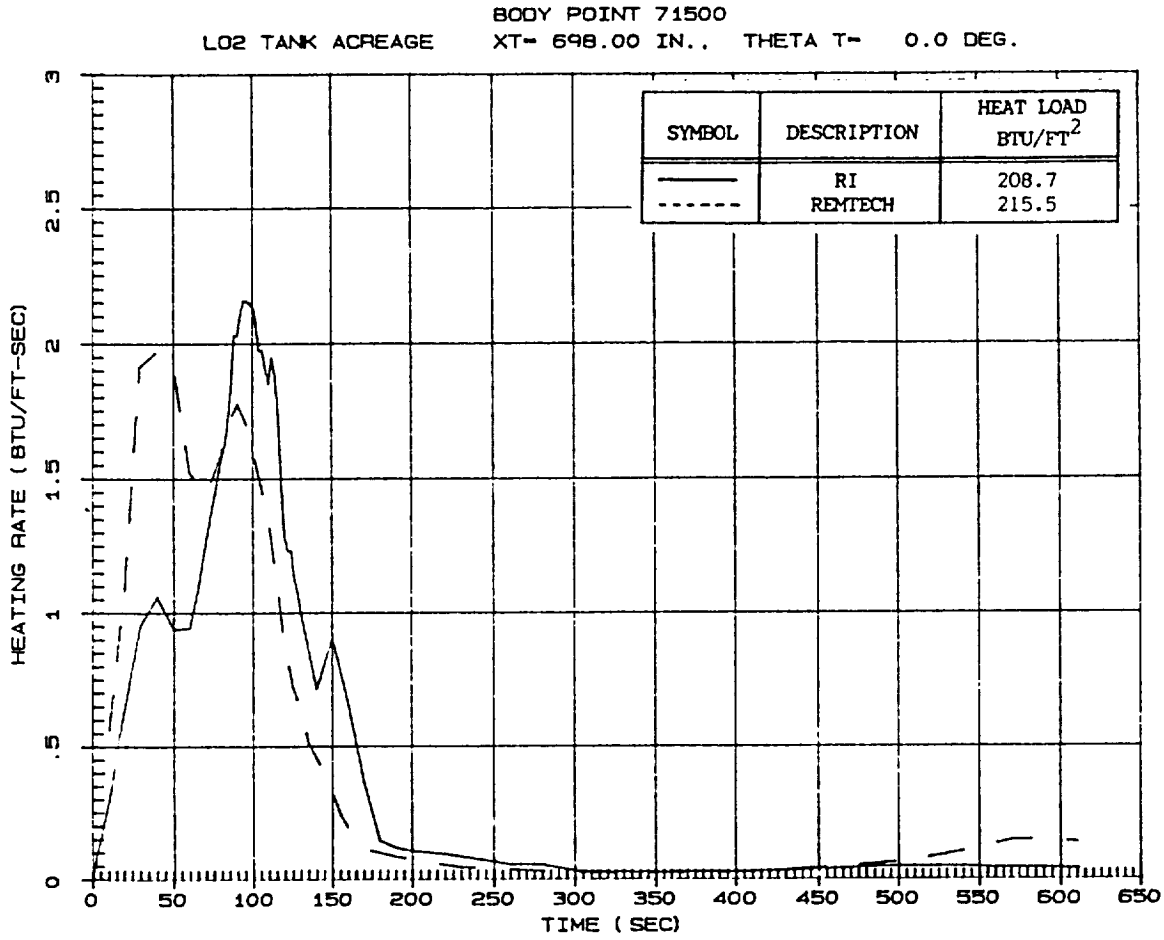

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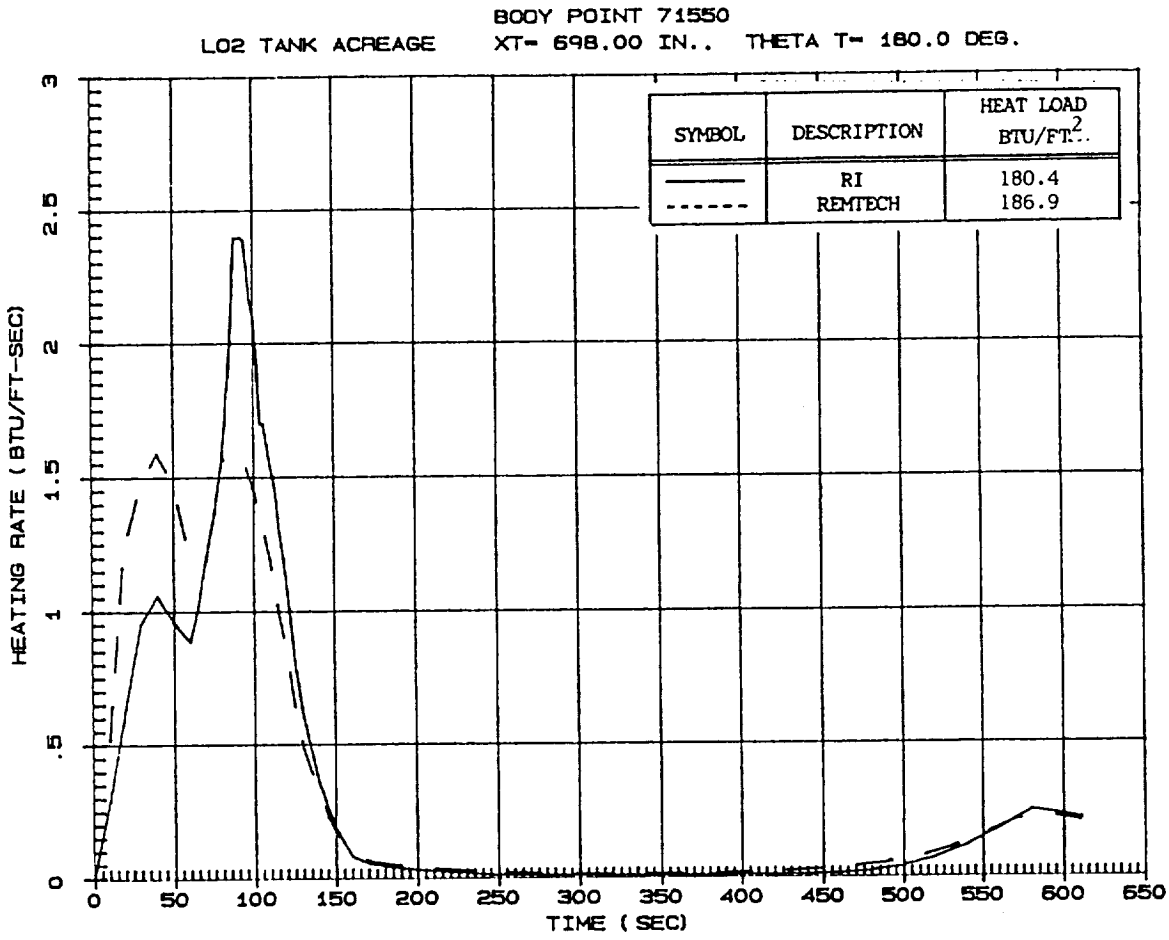

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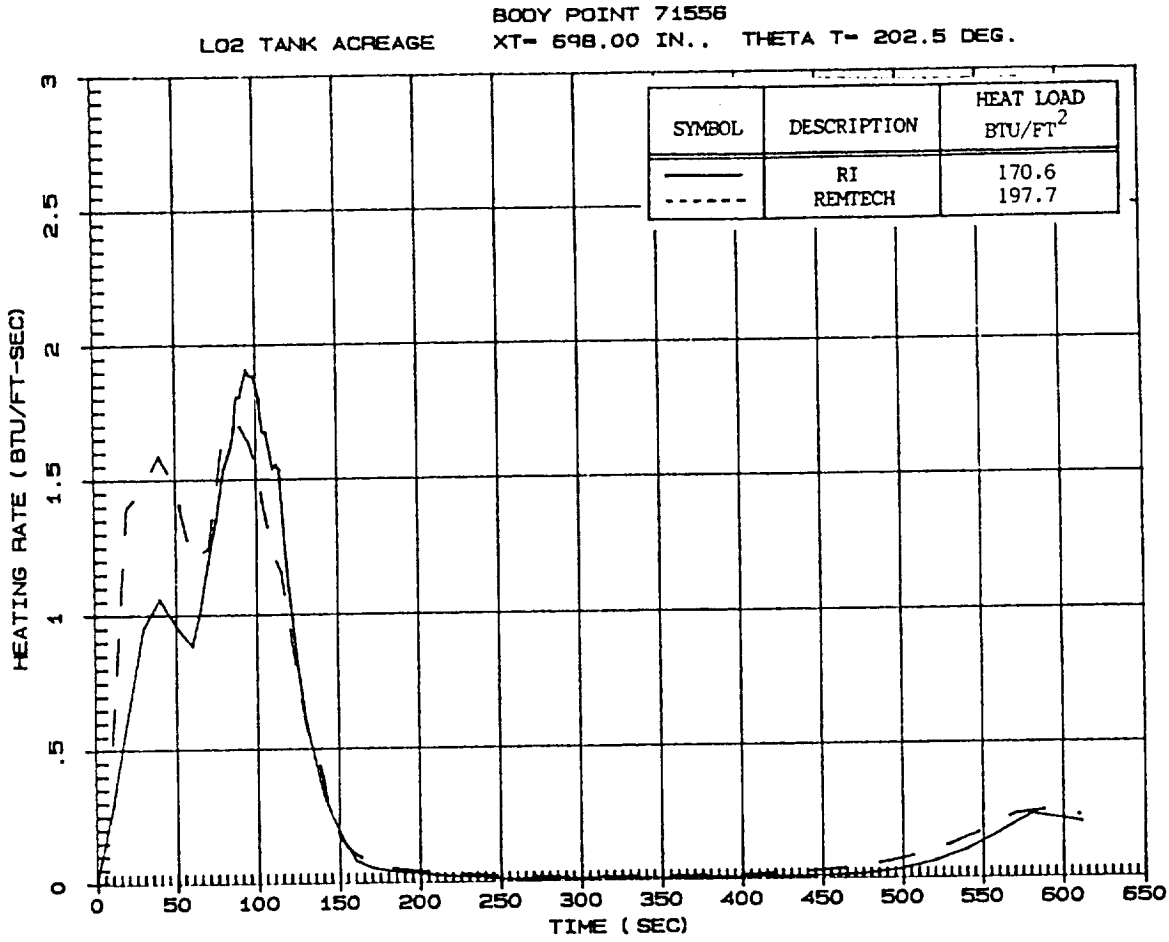

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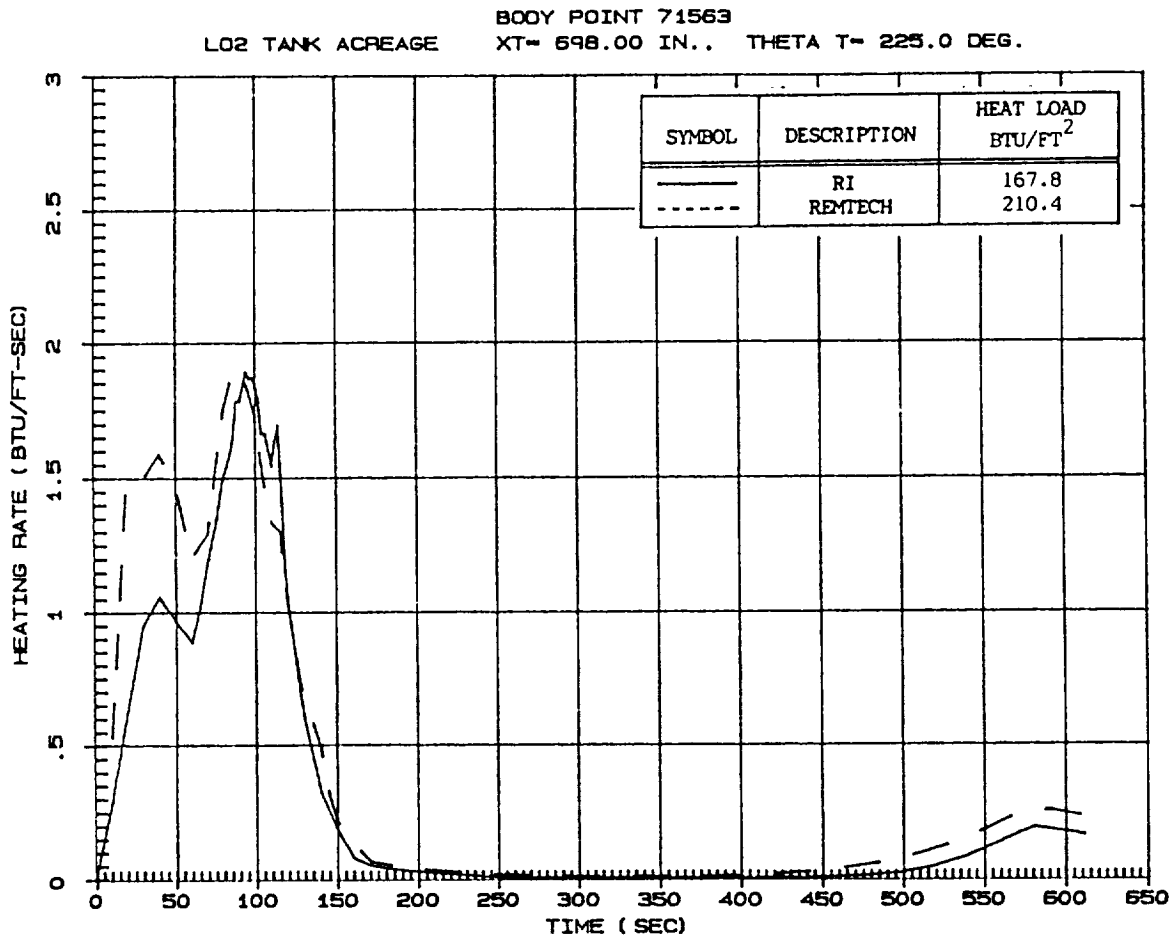

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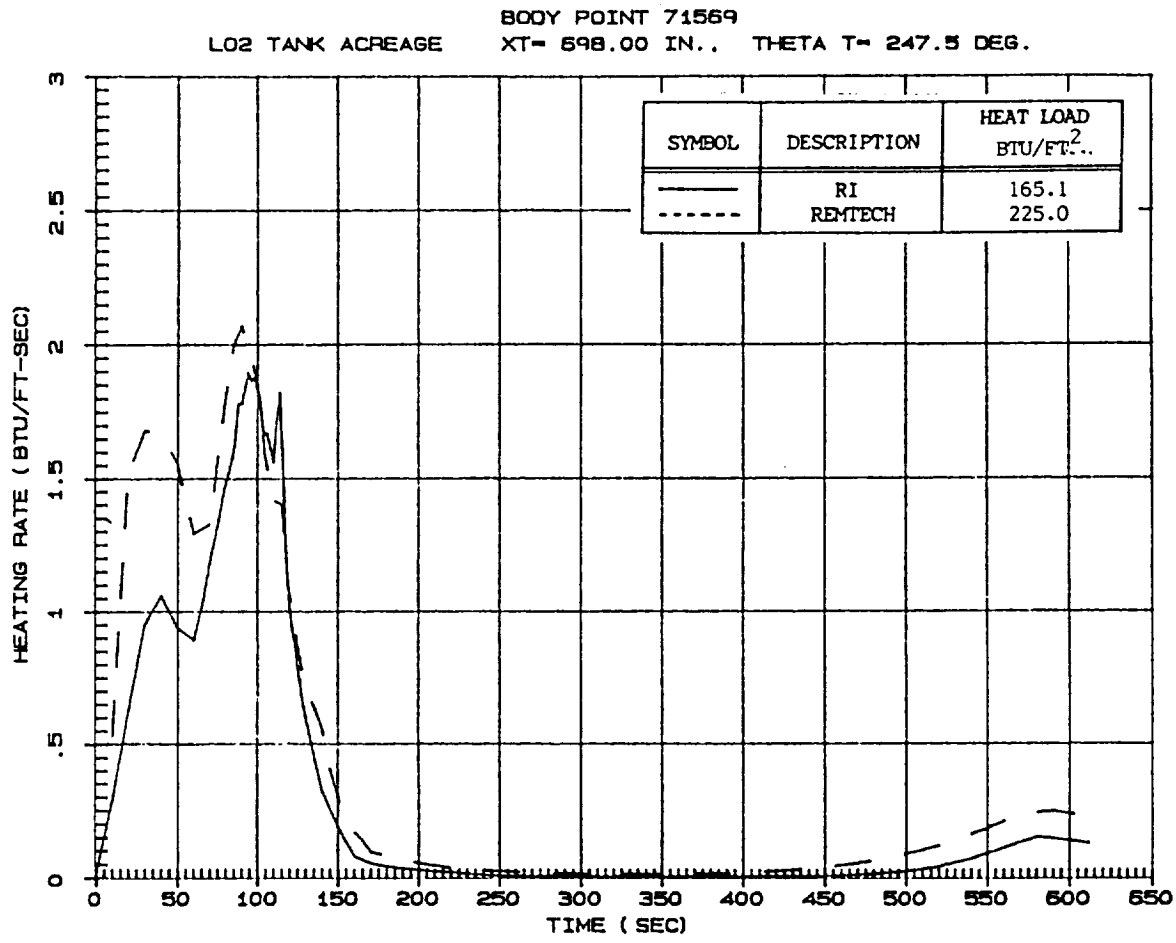

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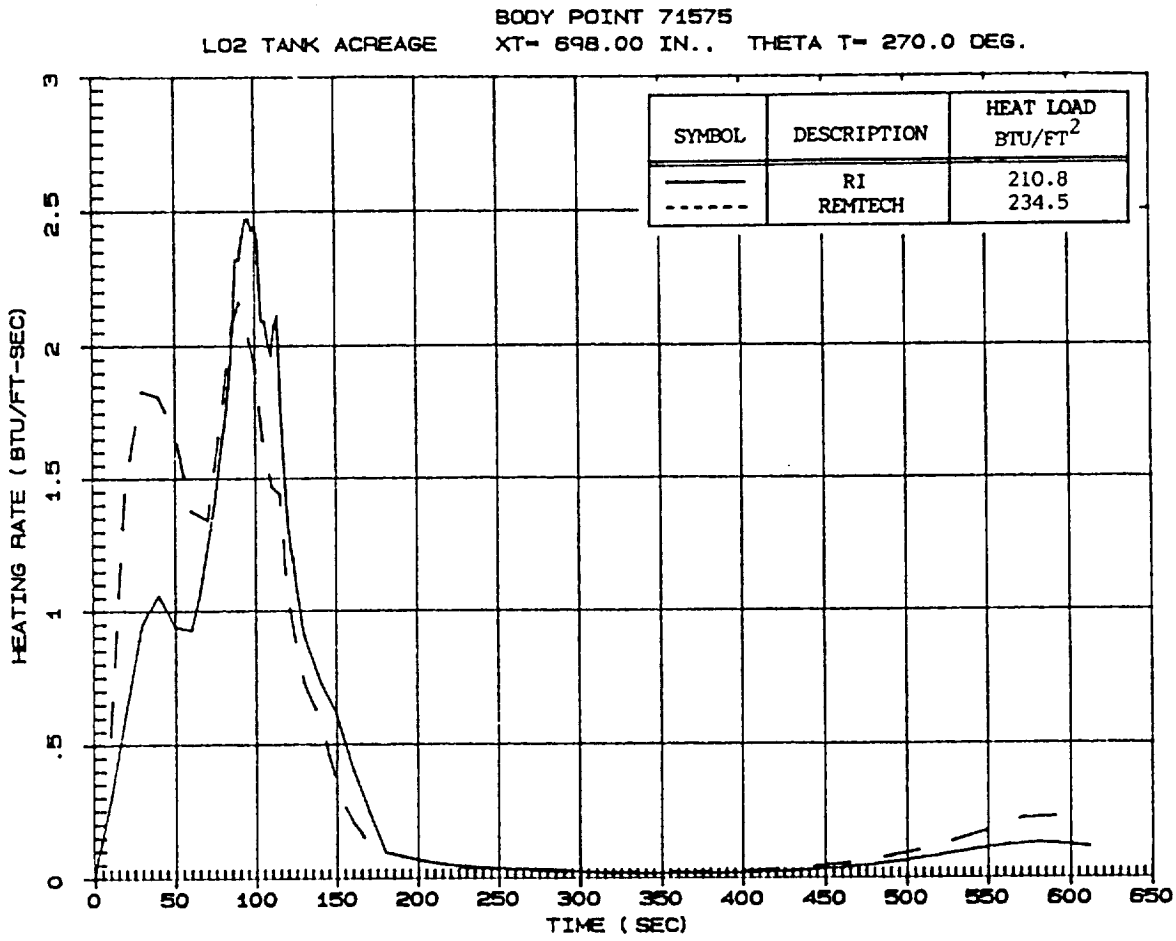

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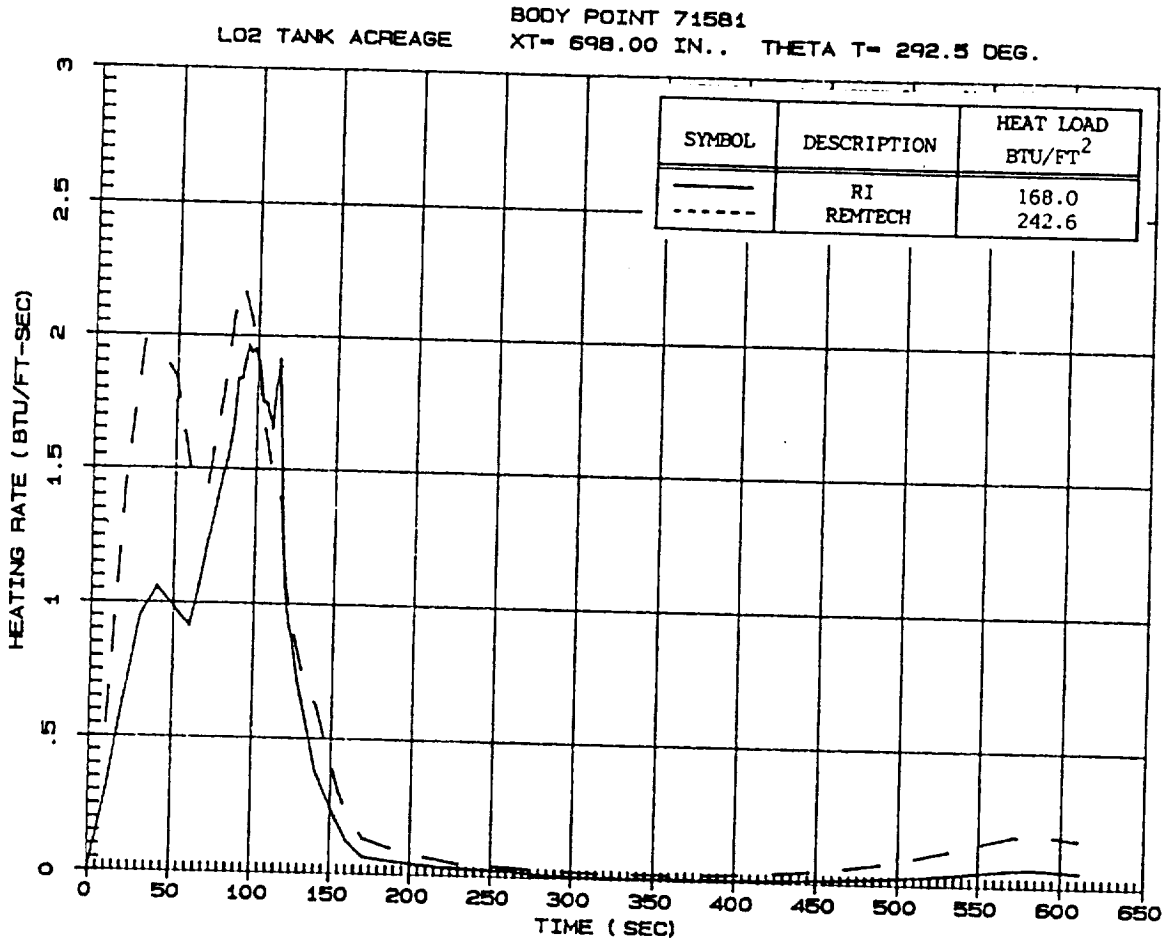

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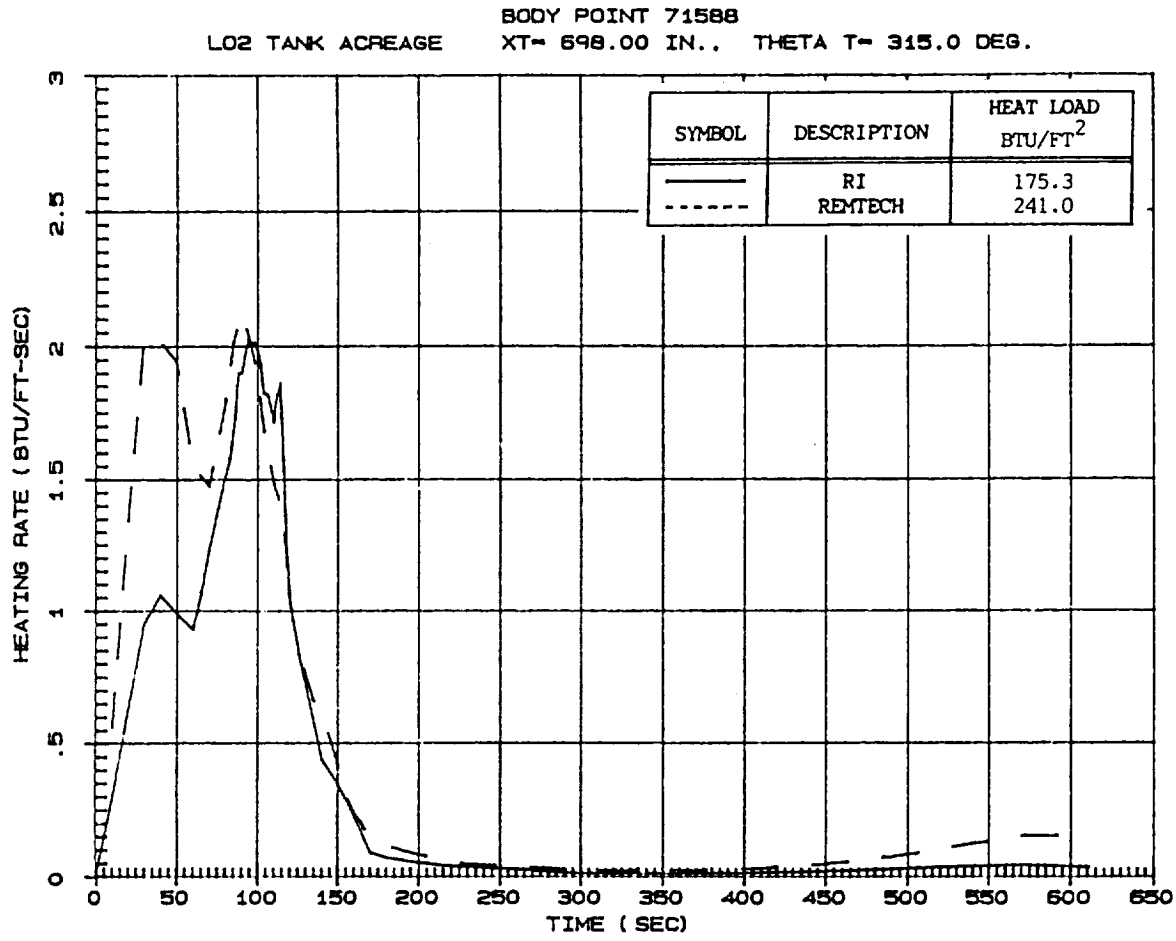

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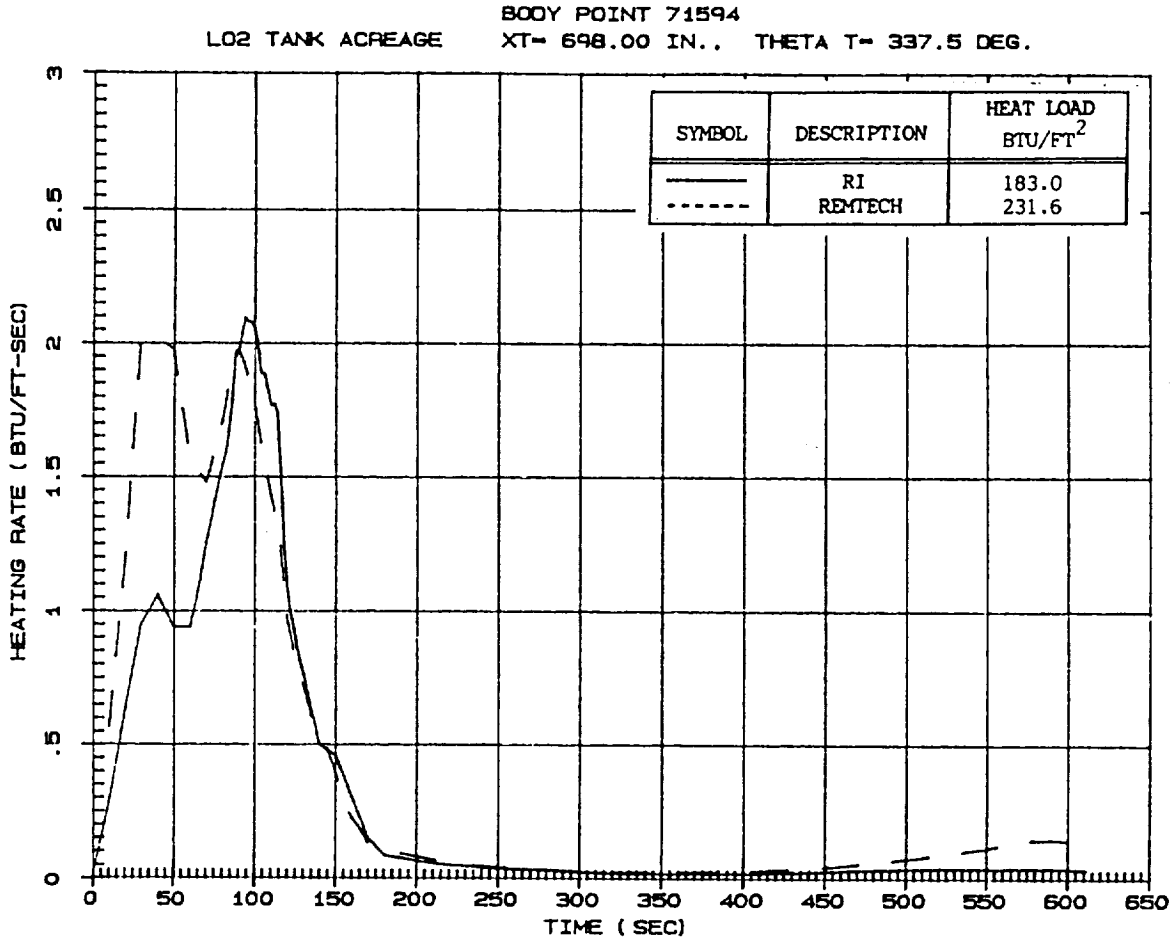

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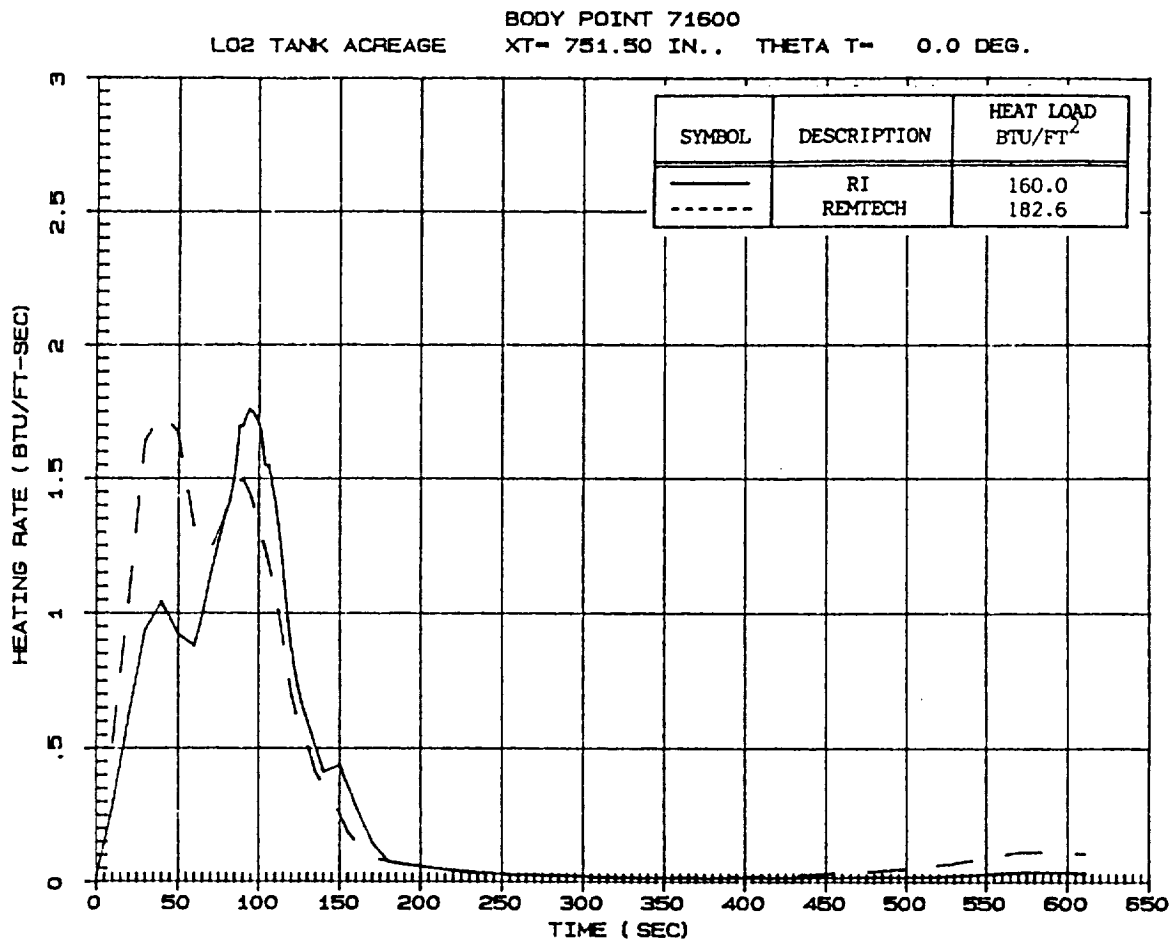

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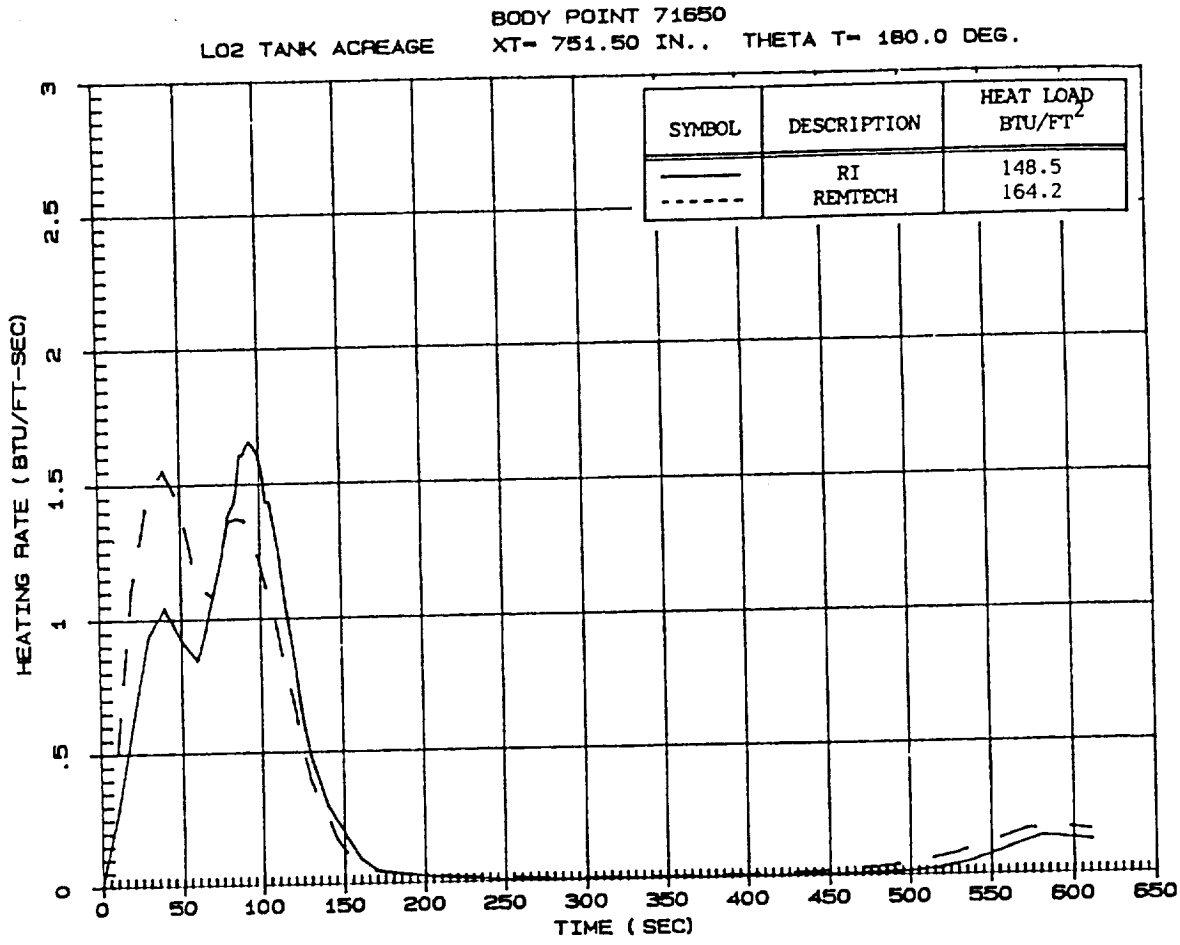

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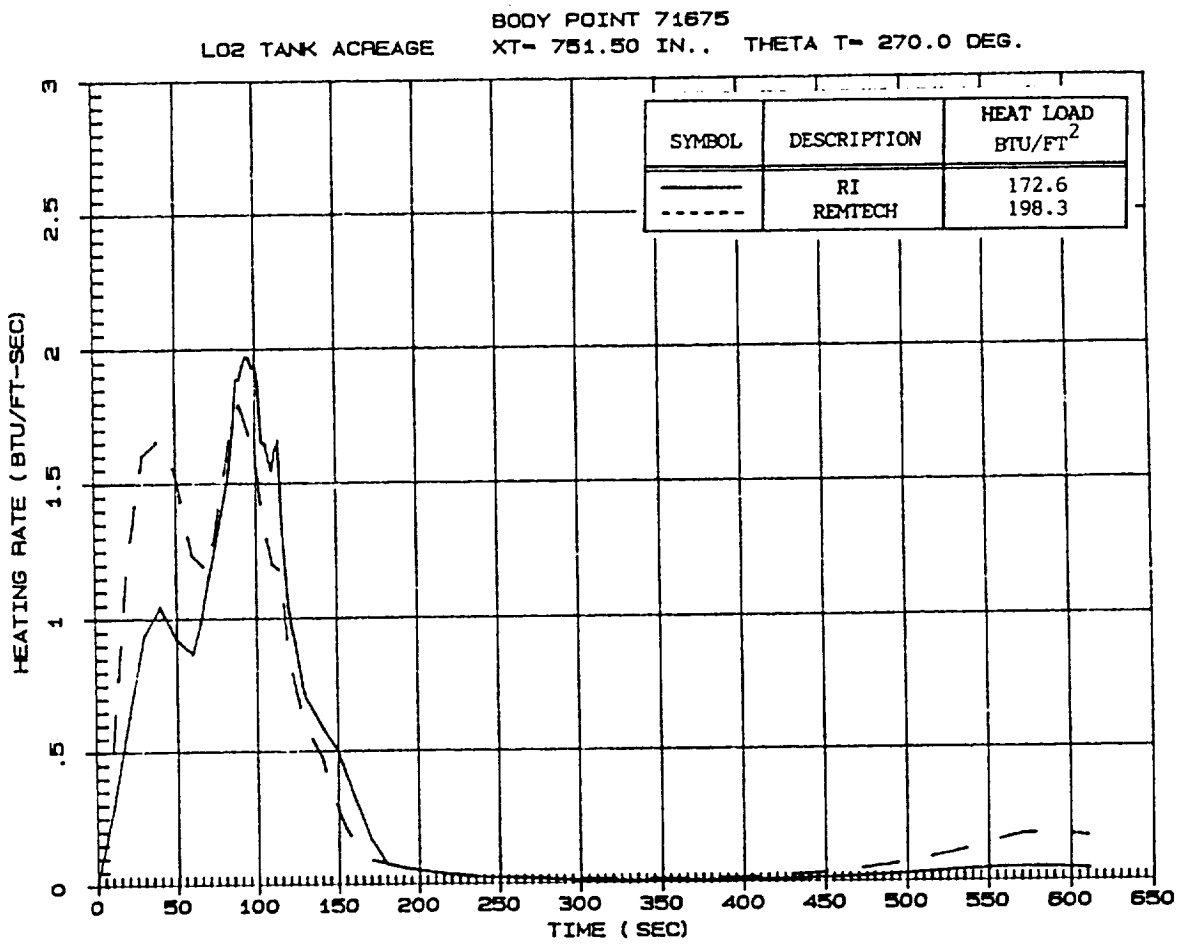

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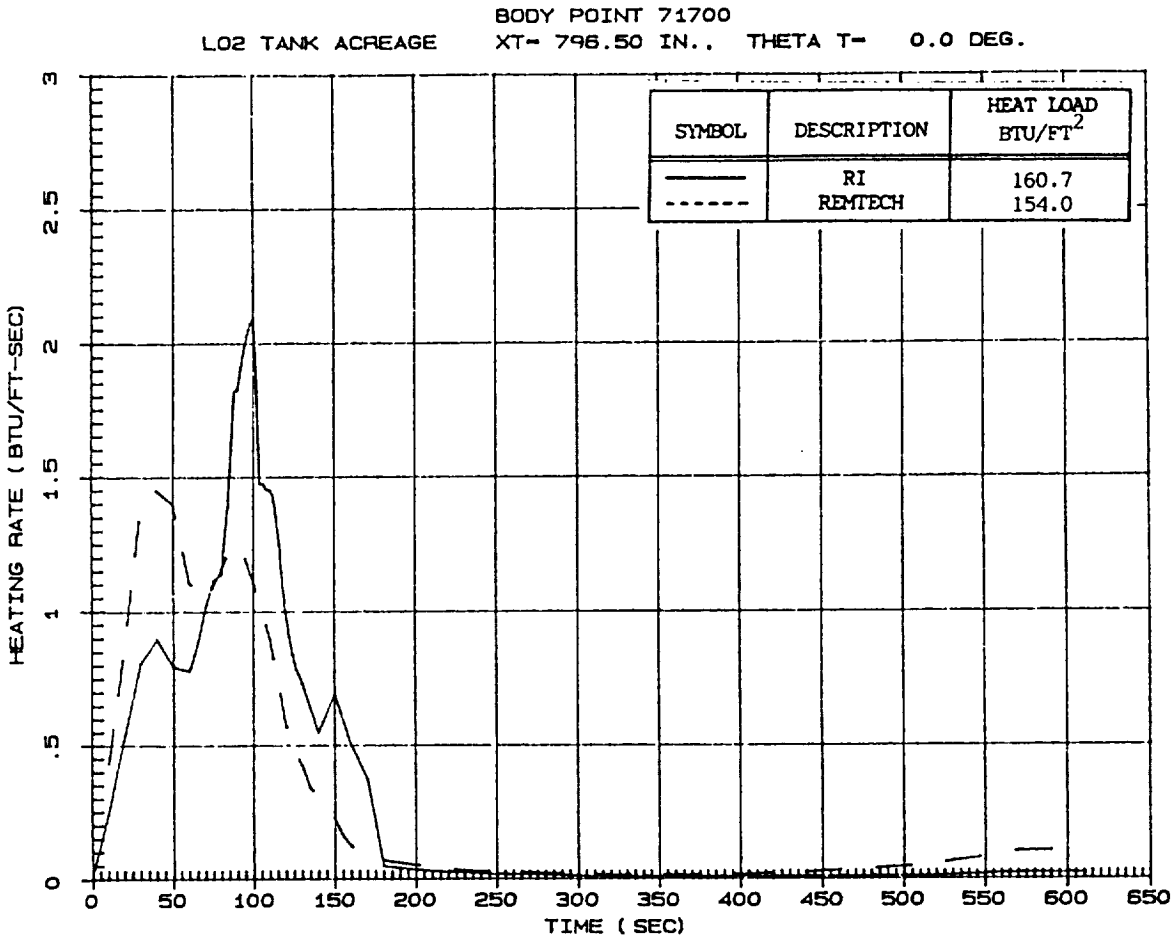

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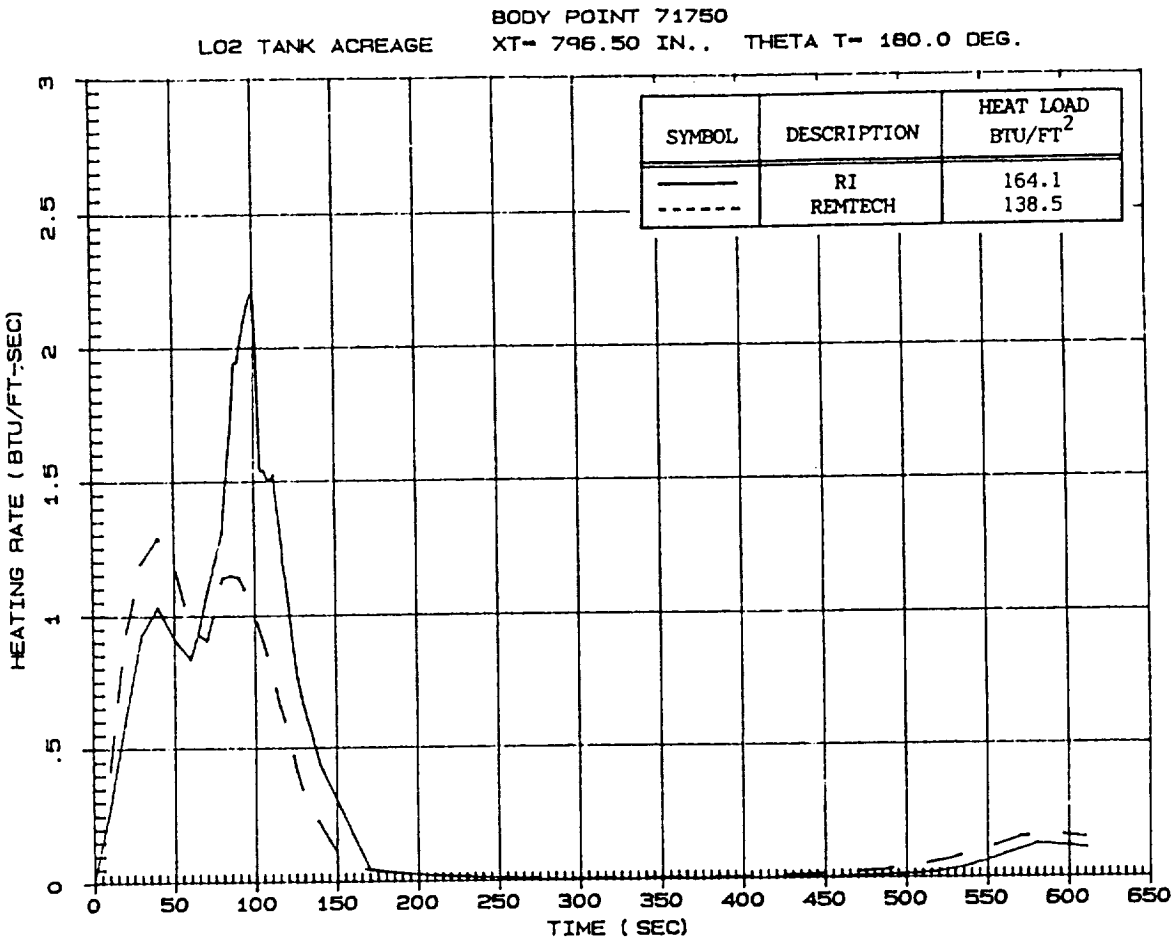

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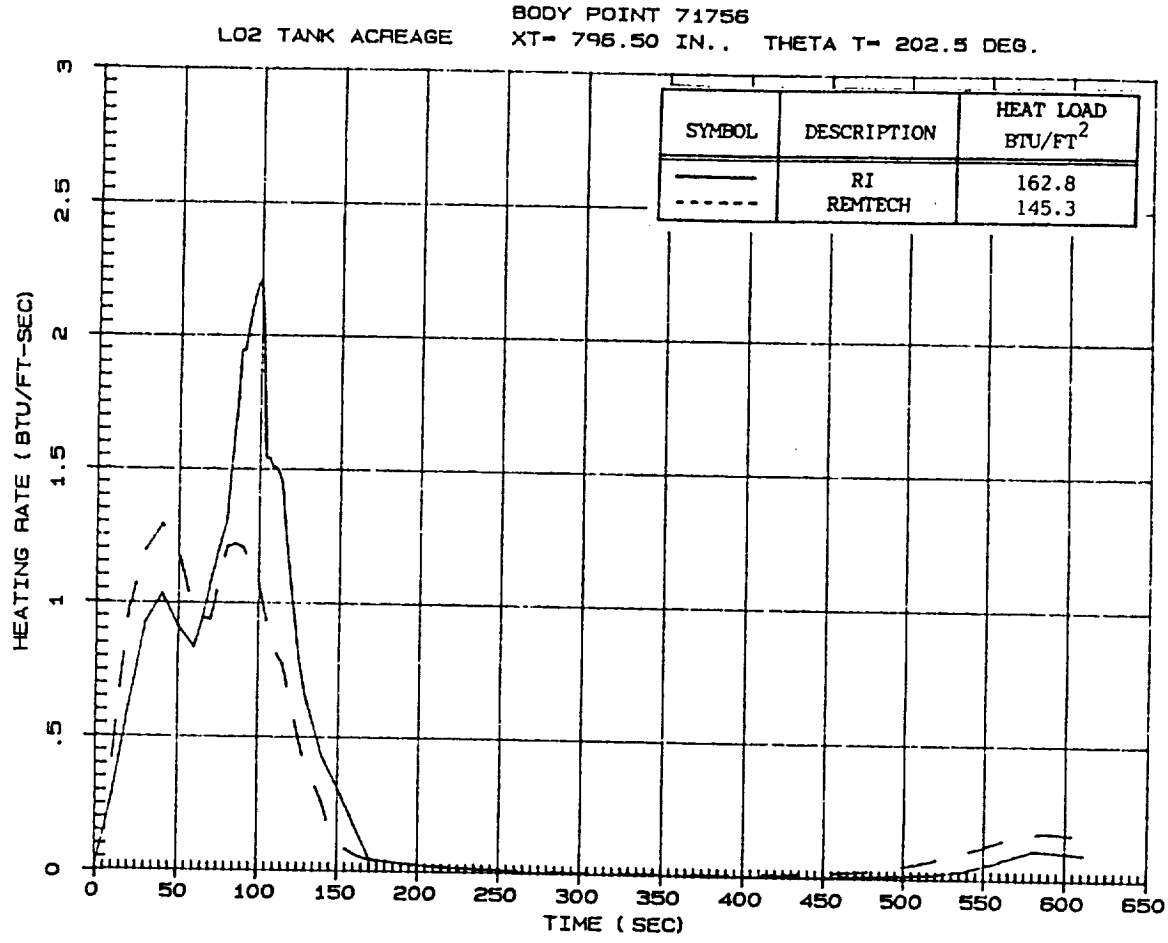

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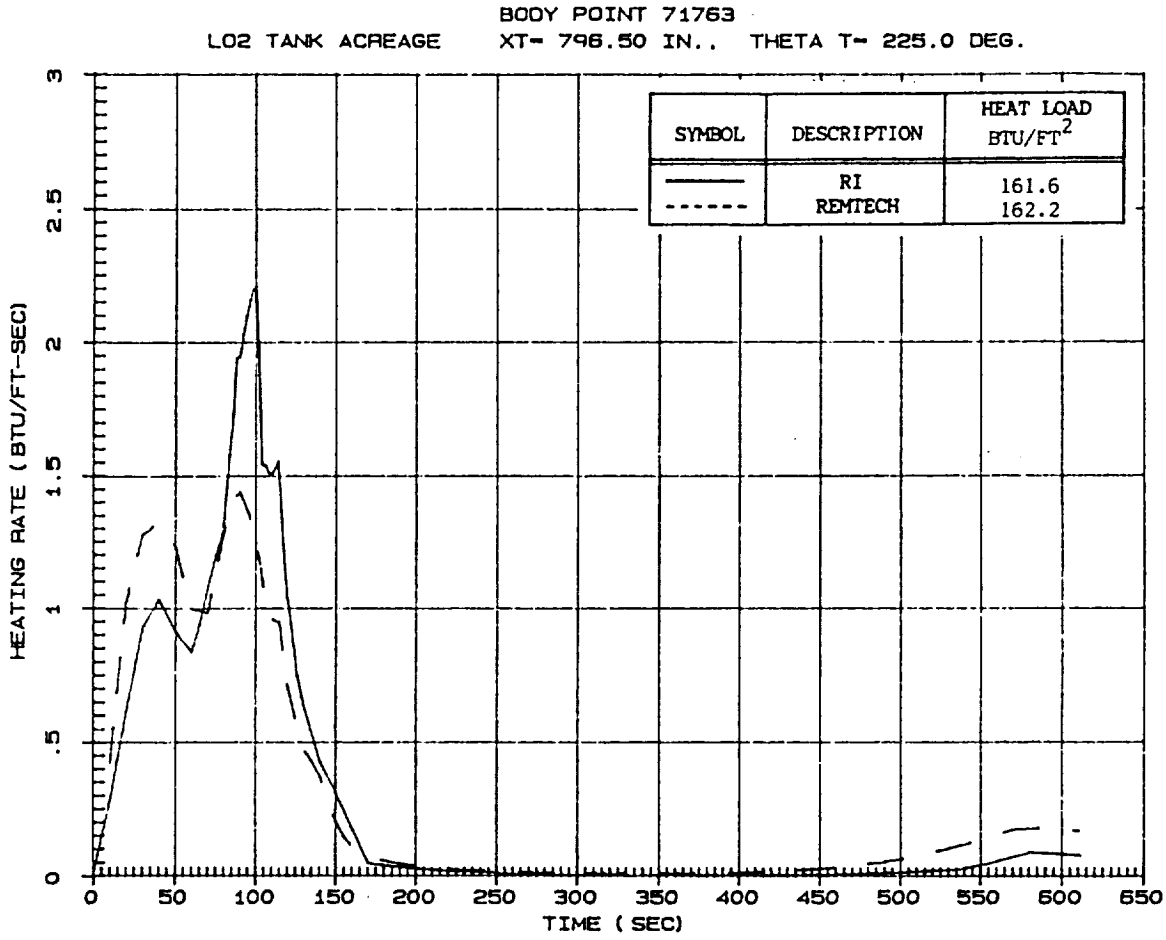

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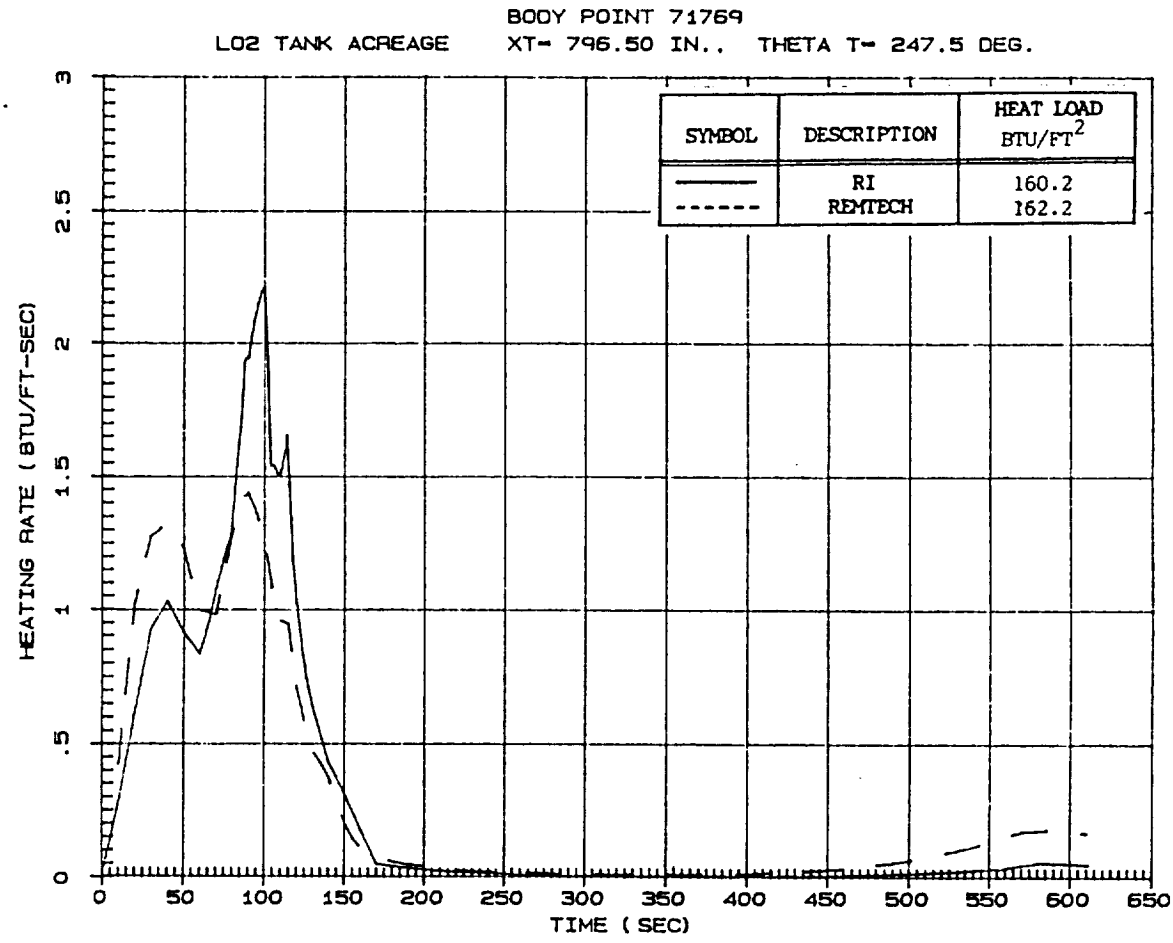

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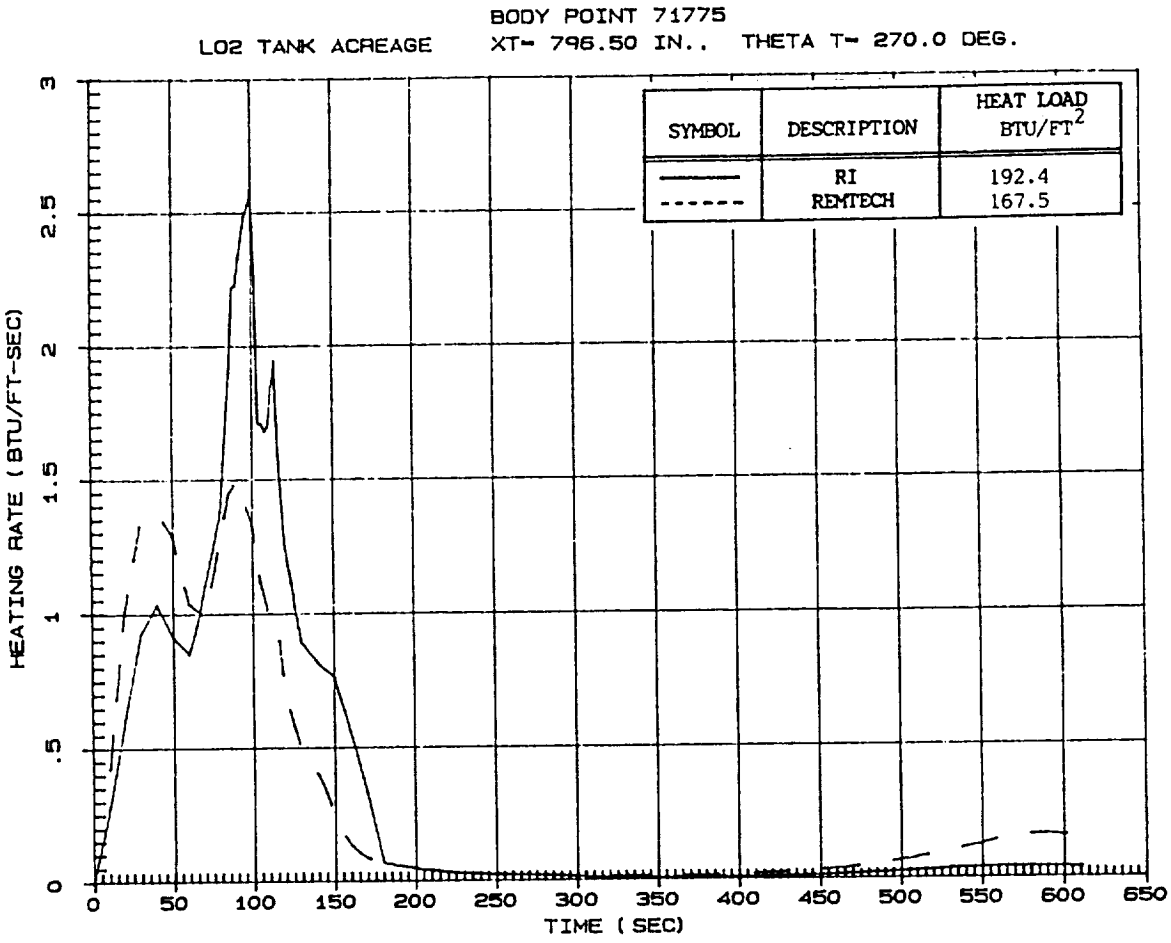
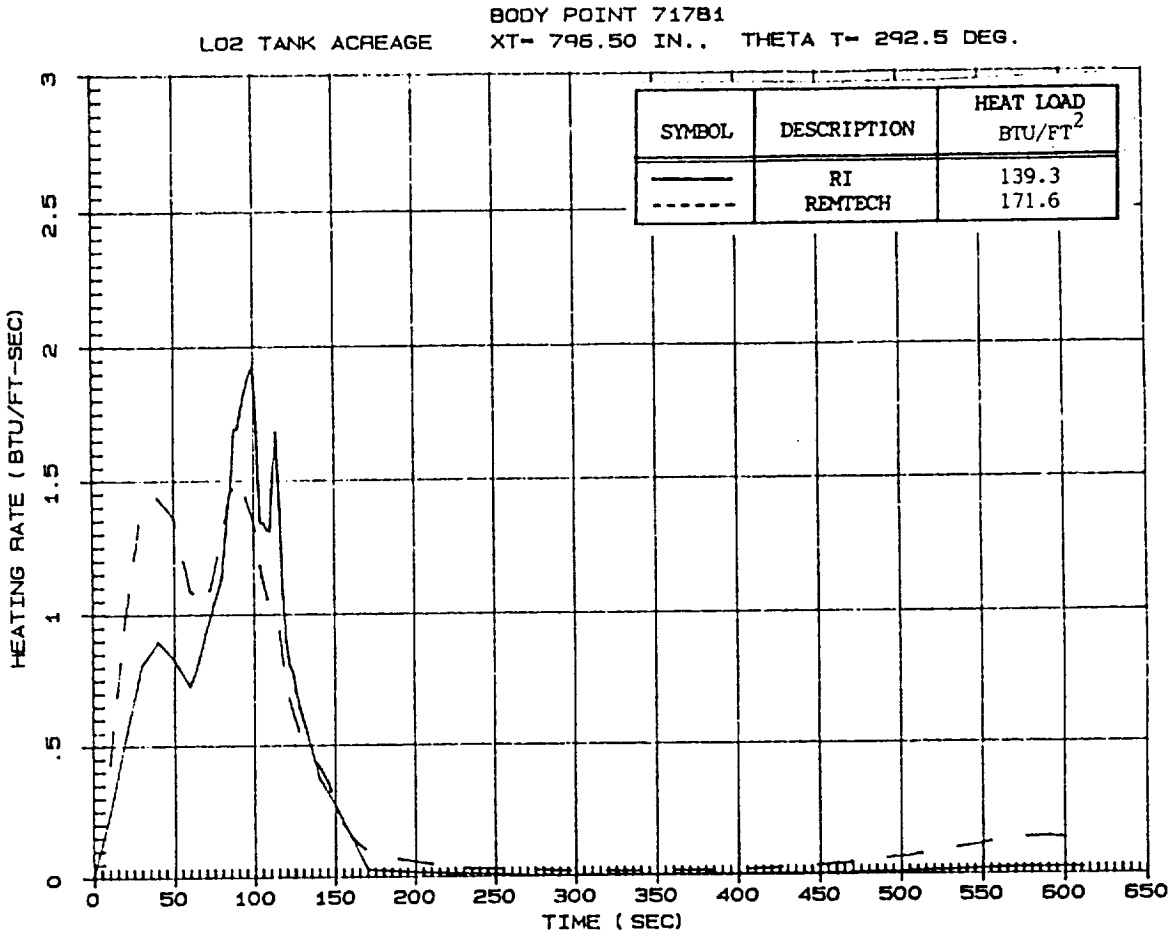
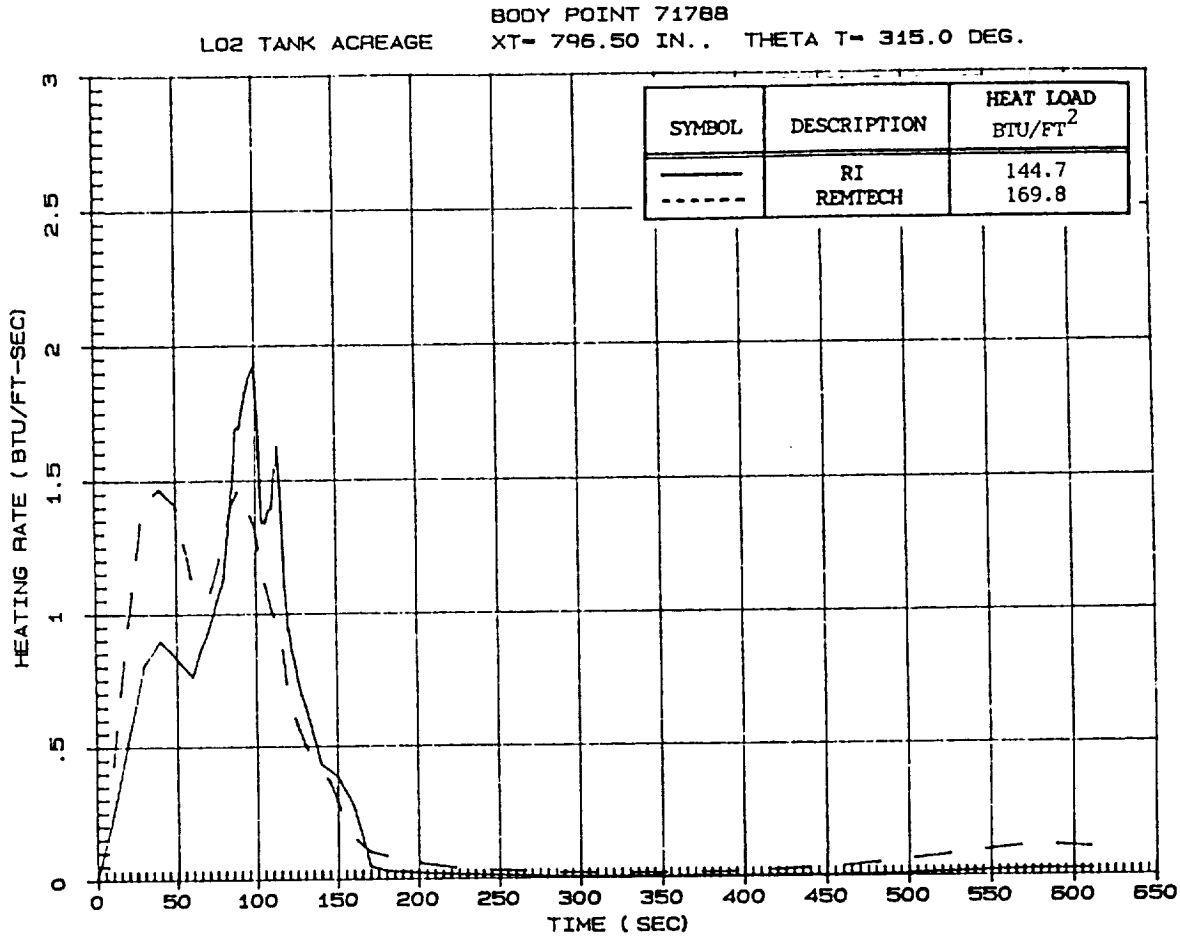


Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



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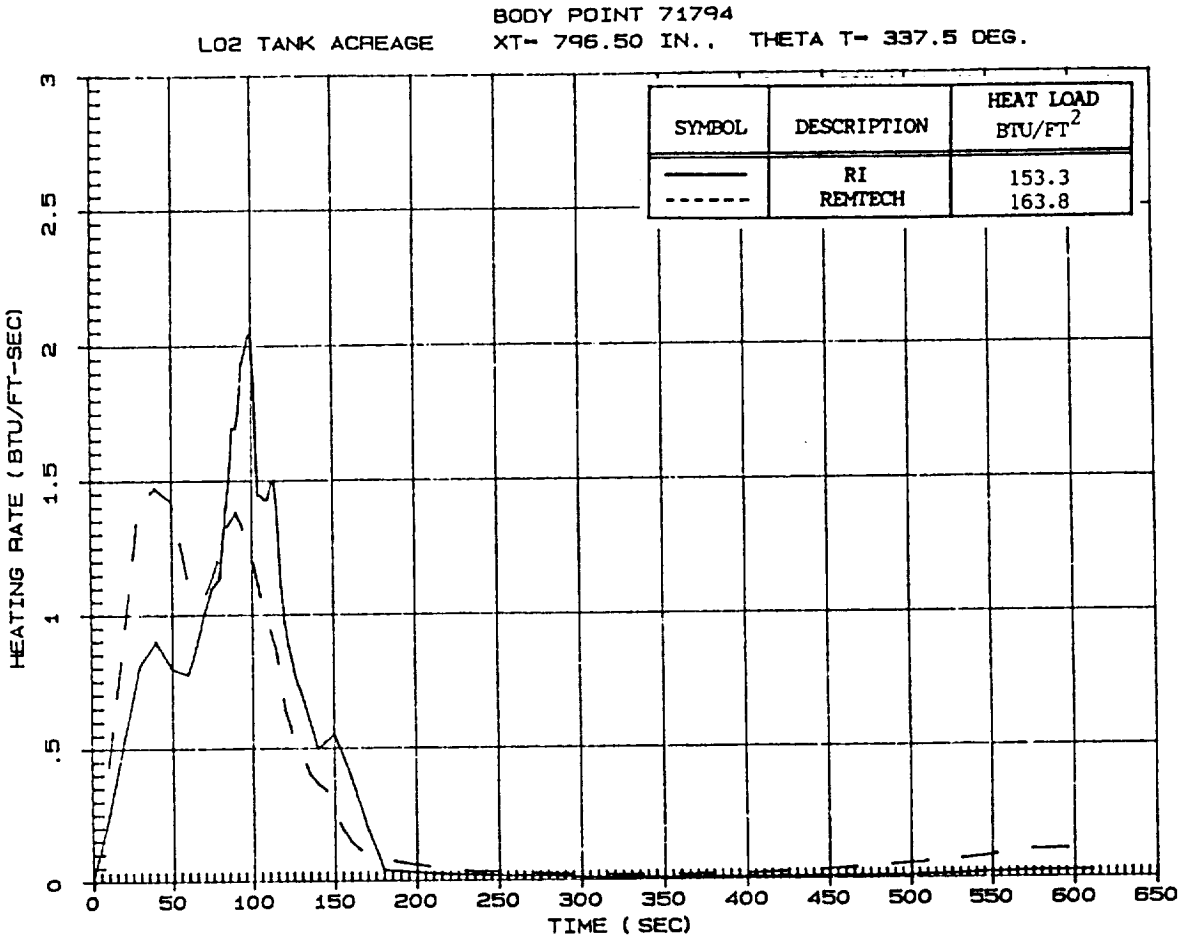

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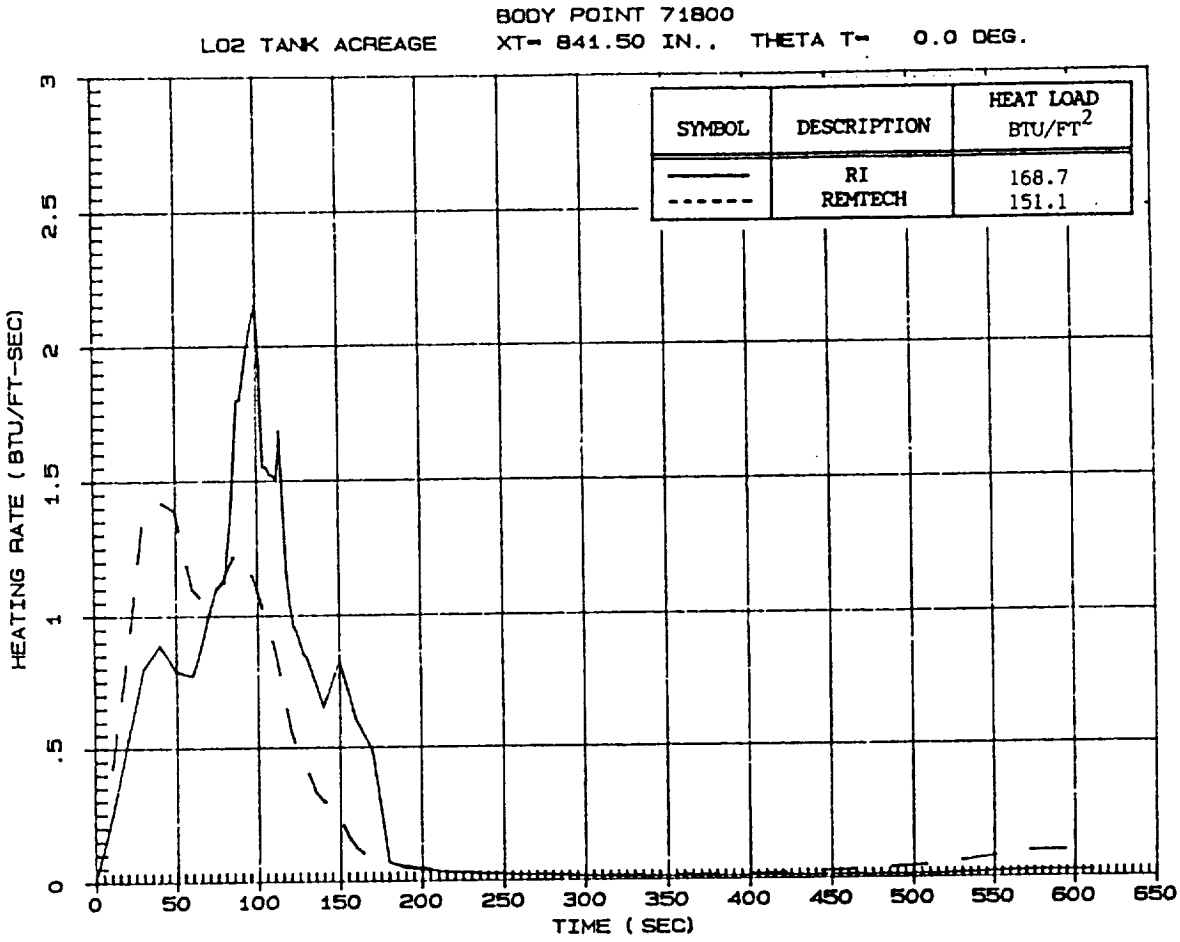

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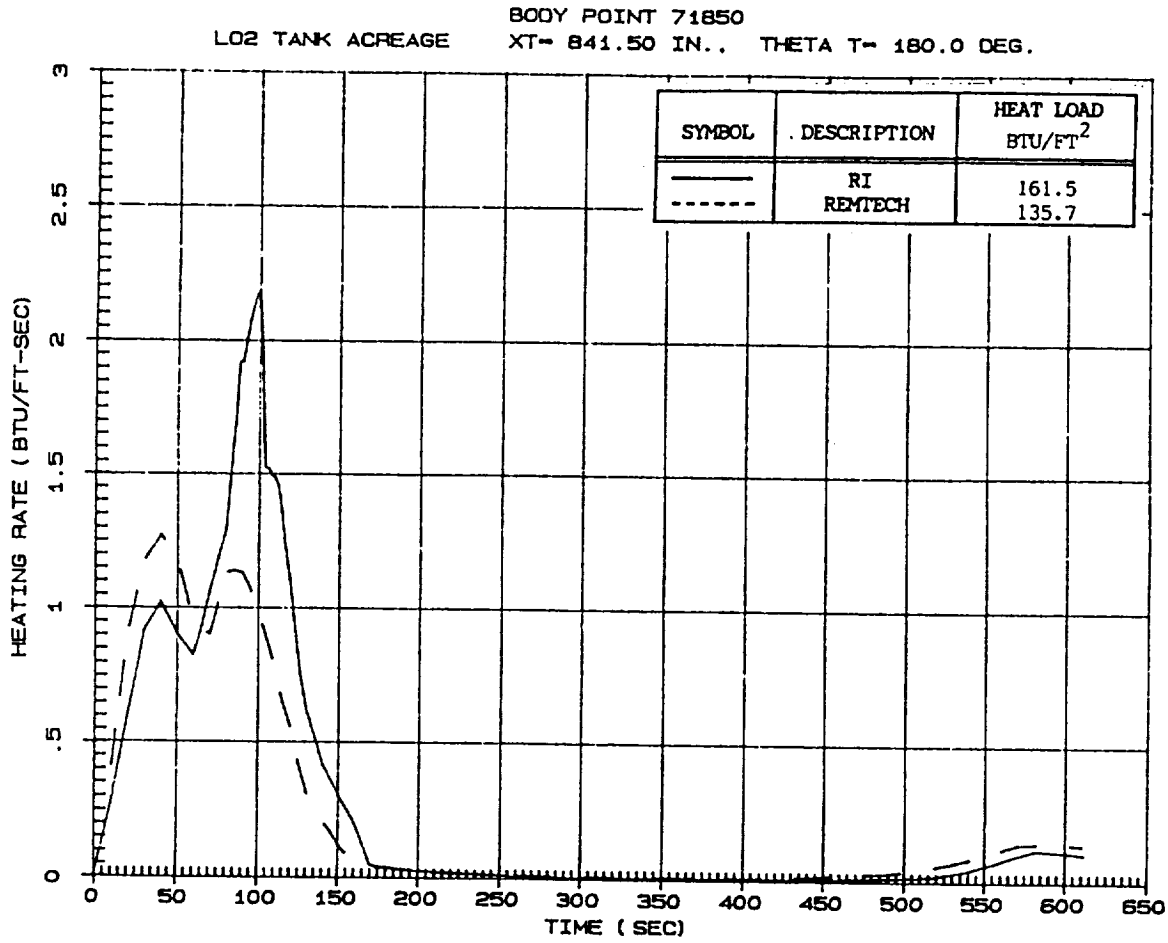
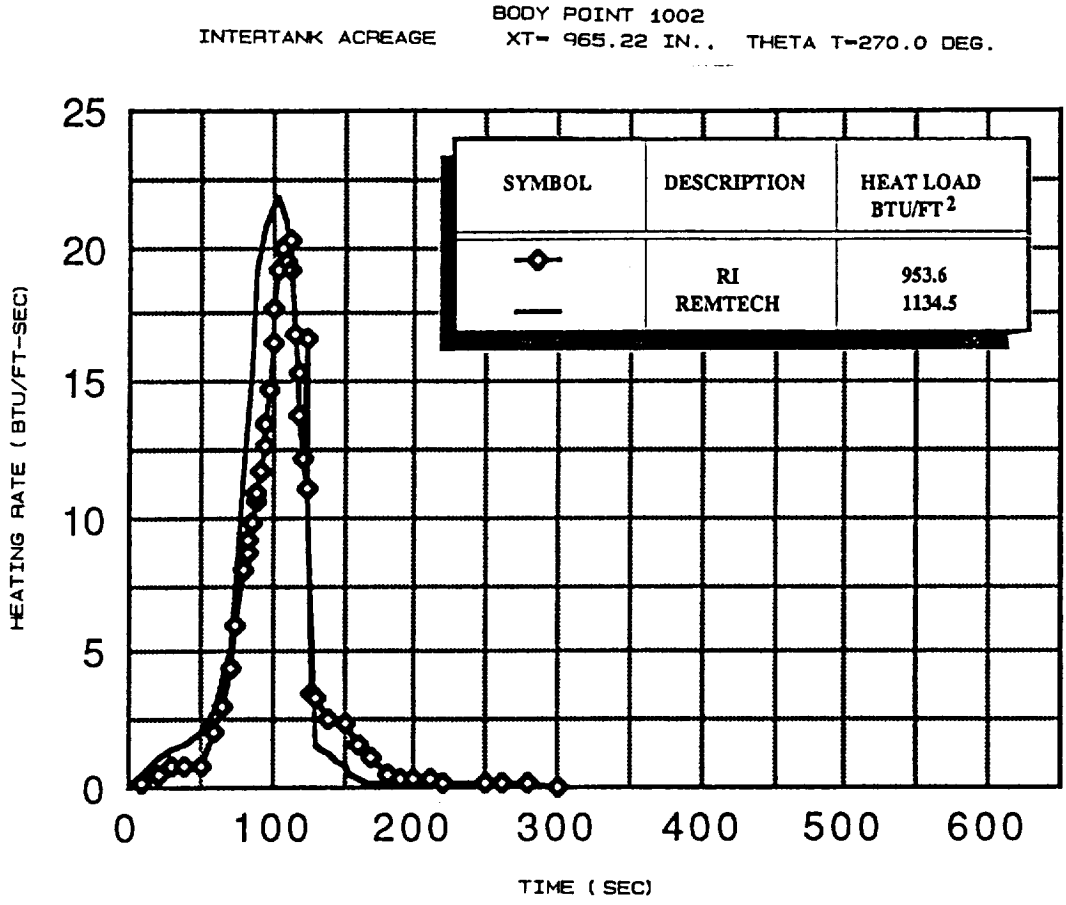


Agreement is acceptable; no TPS impact.

ASCENT DESIGN ENVIRONMENTS FOR THE ET INTERTANK ACREAGE BODY POINTS



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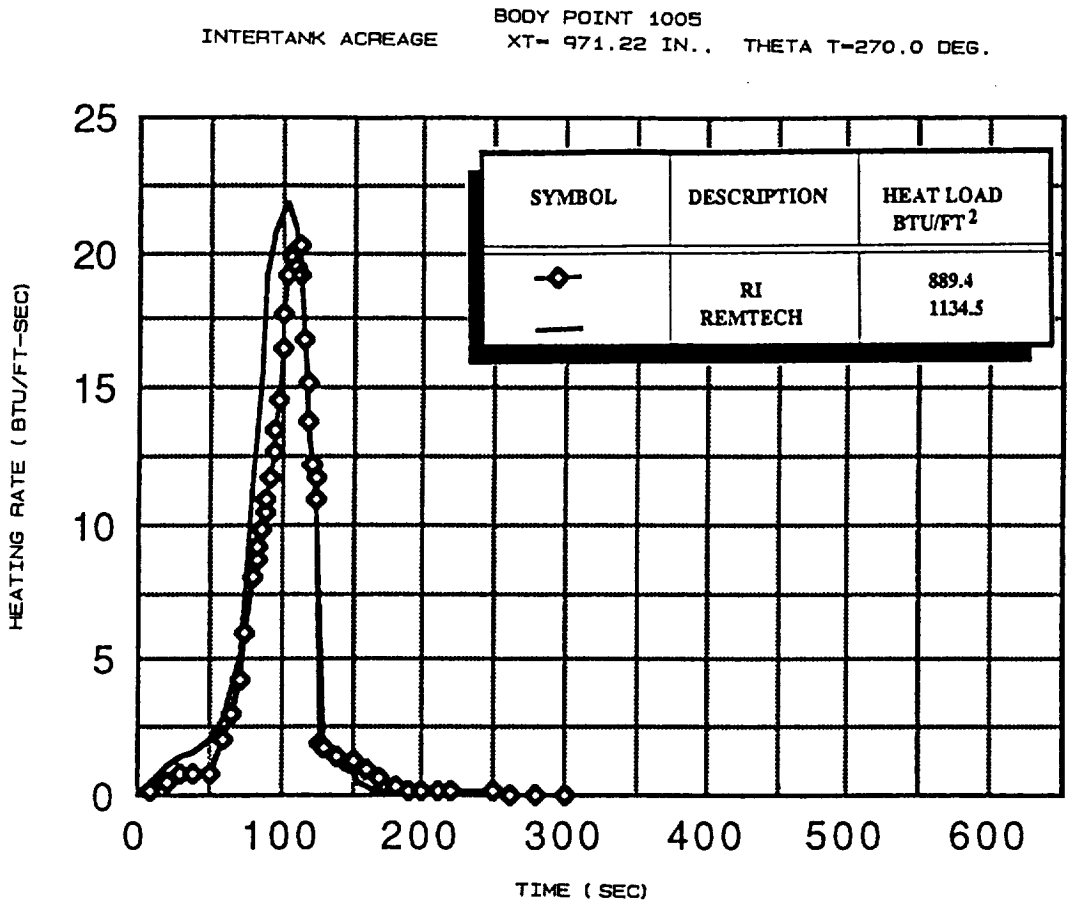

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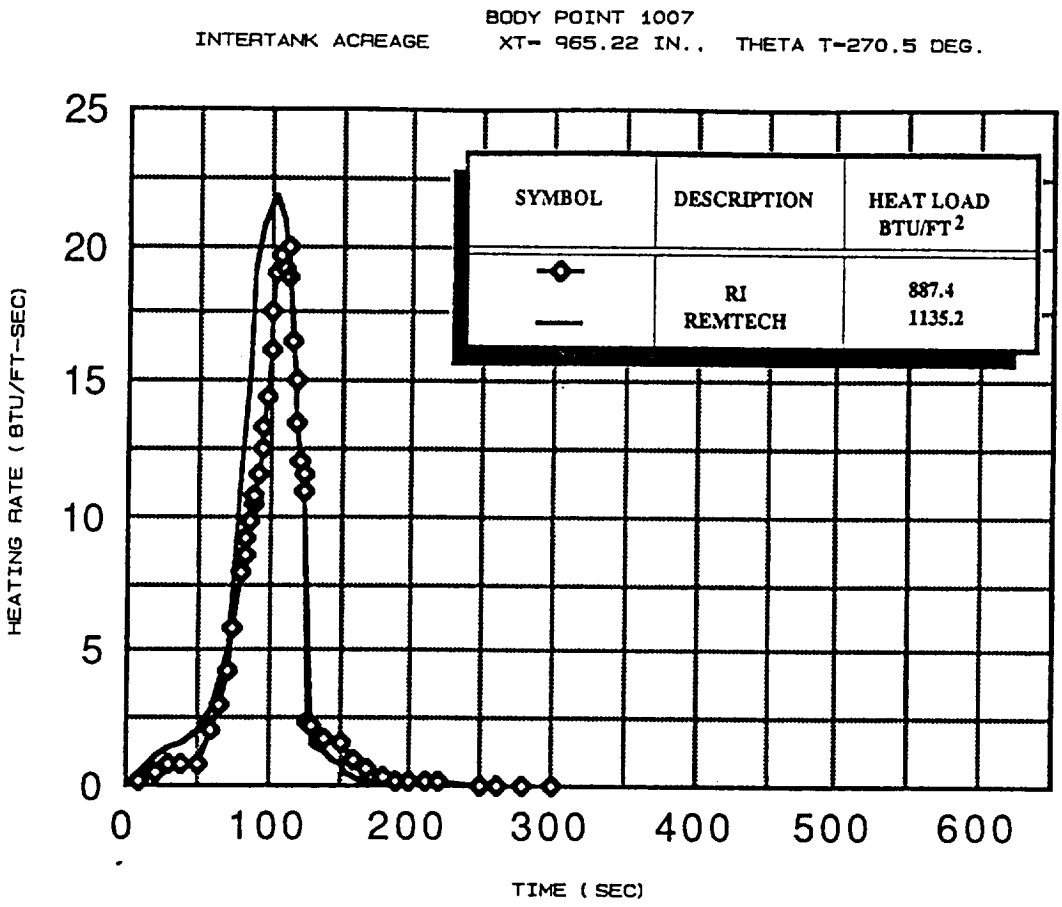

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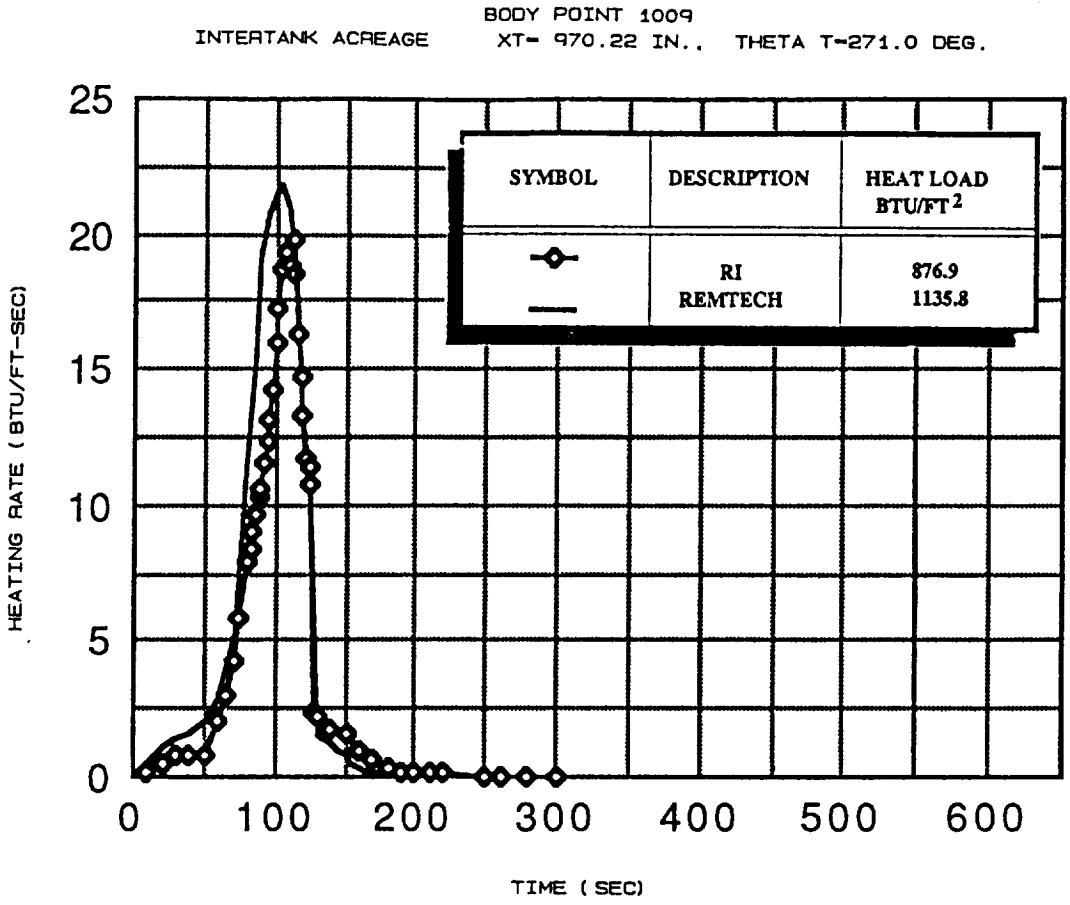
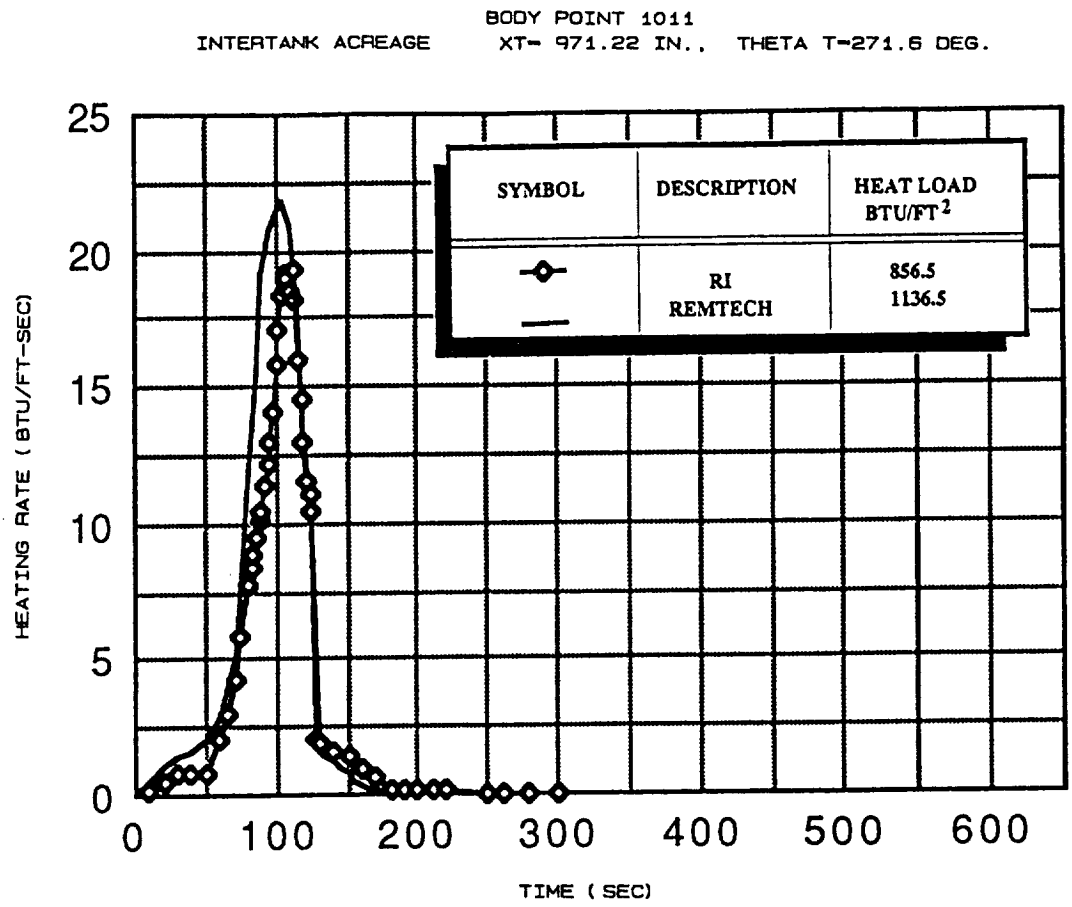
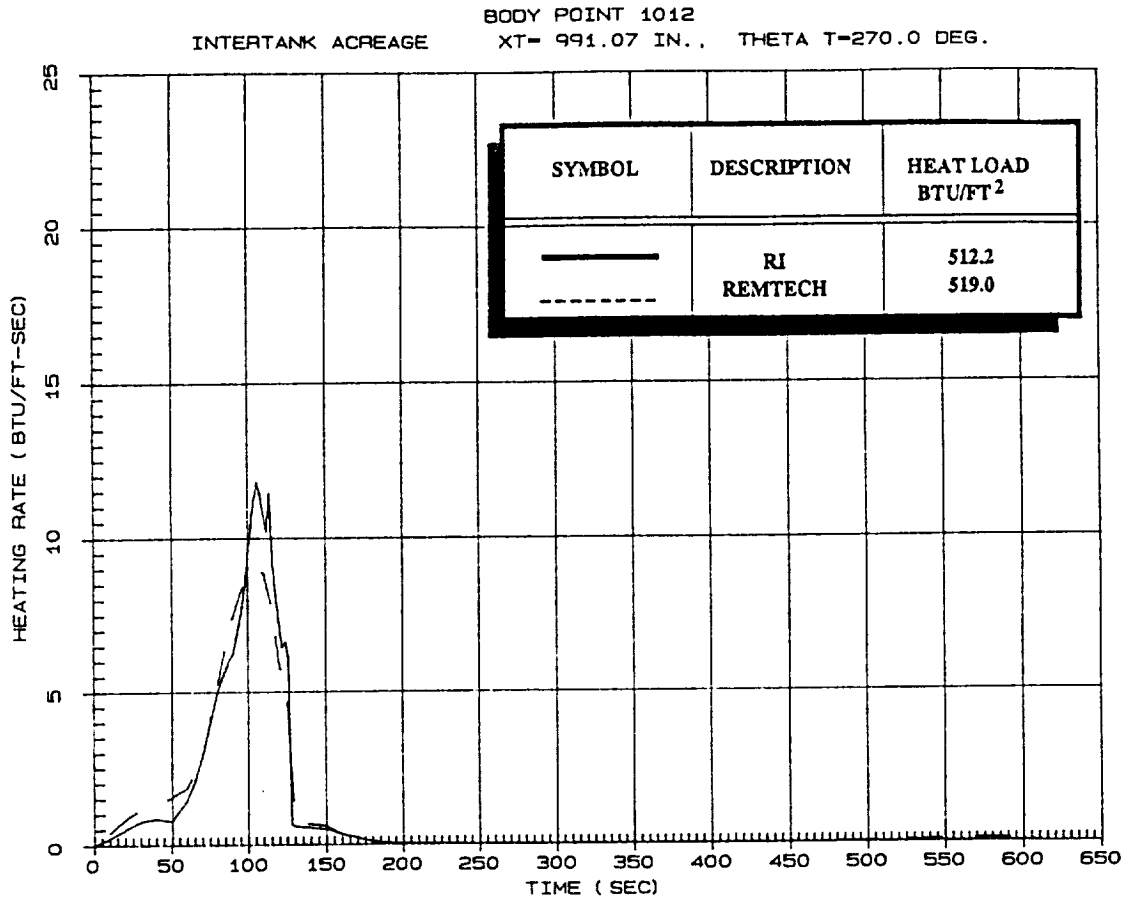


Agreement is acceptable, no TPS Impact.



Agreement is acceptable; no TPS impact.



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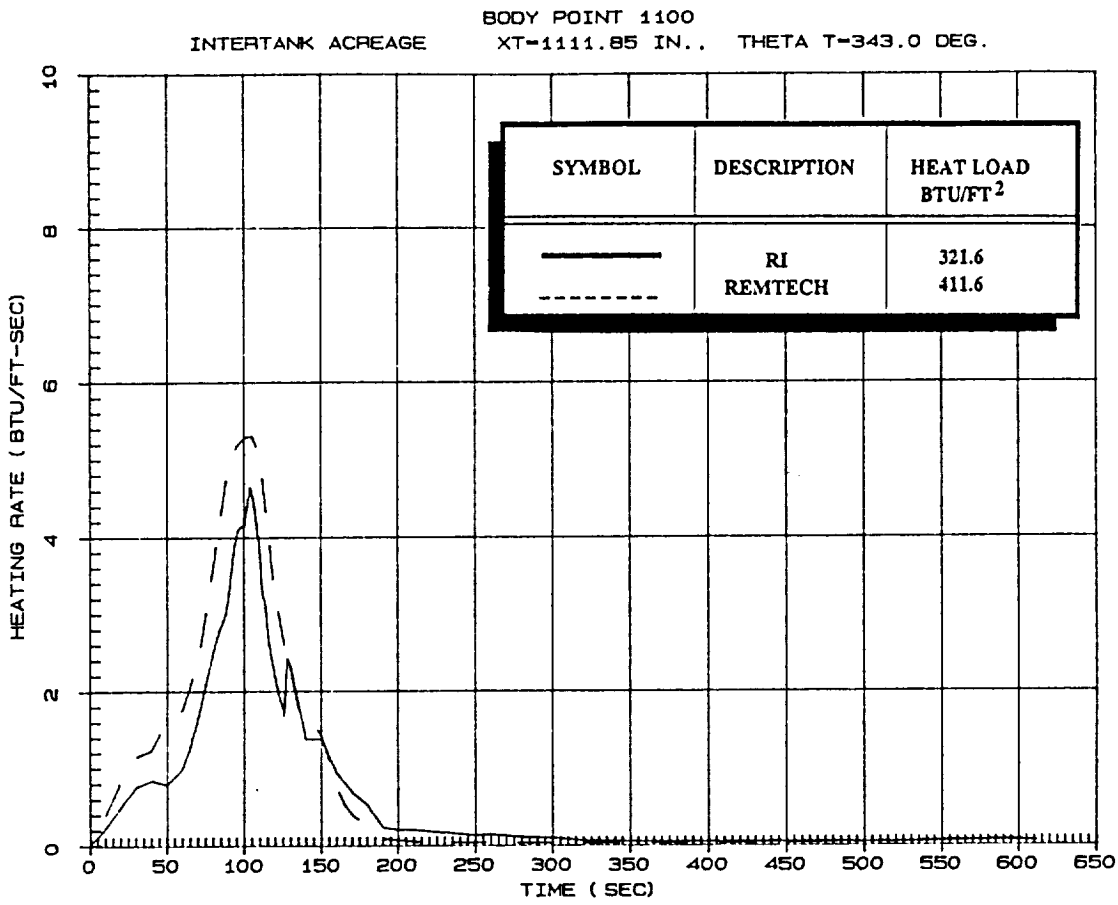
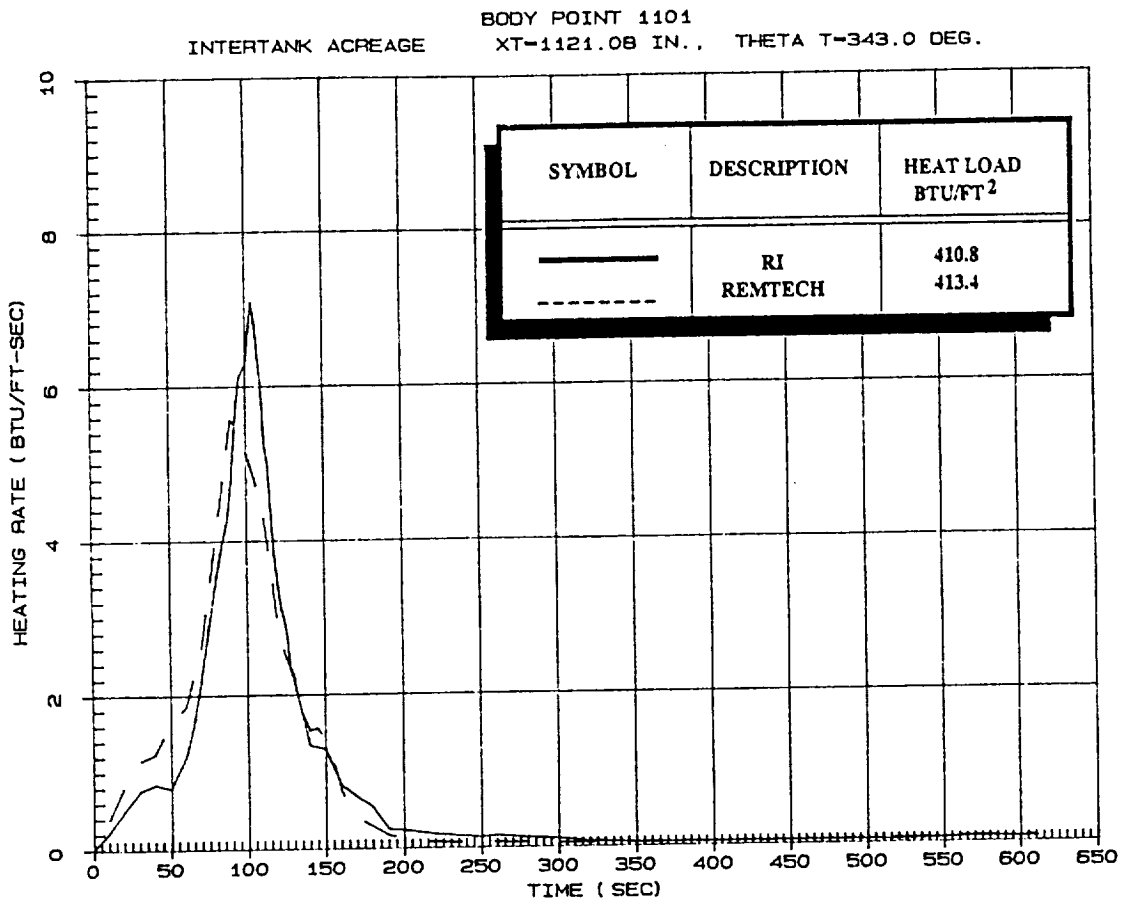
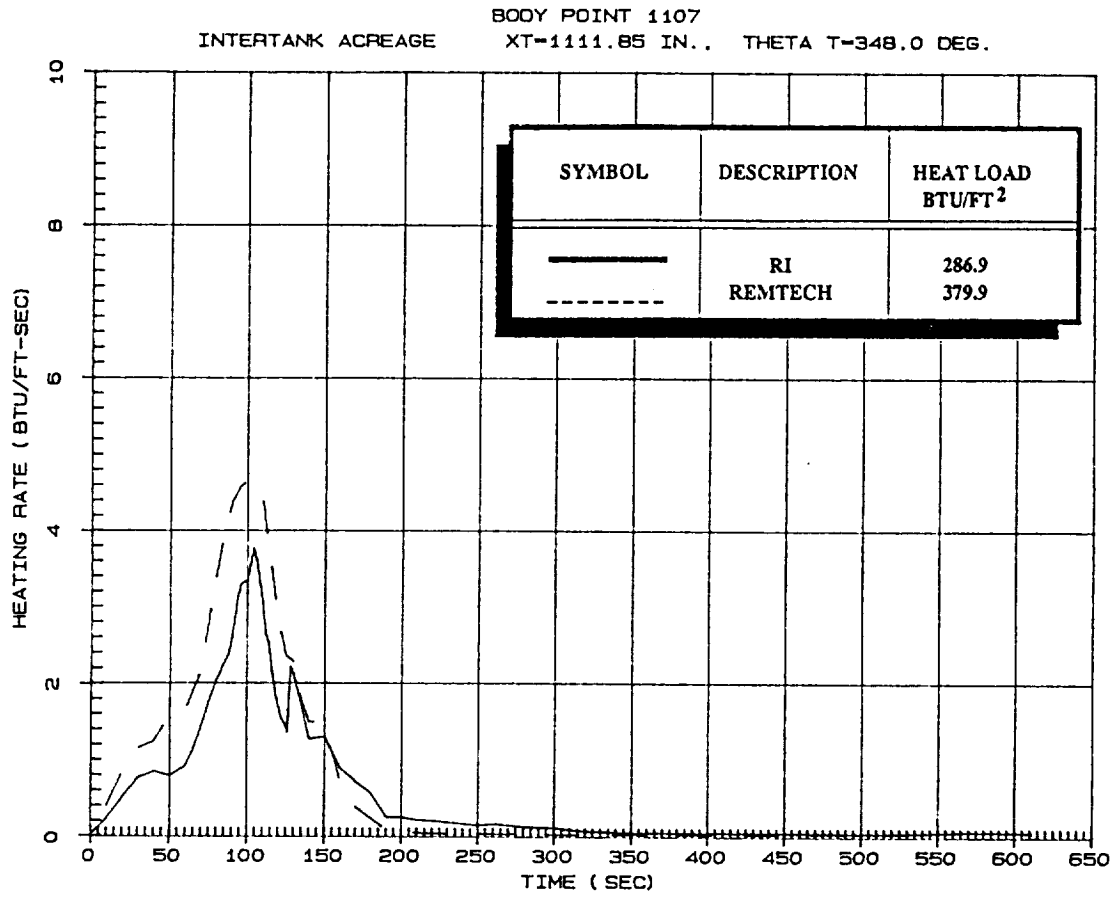


- Difference in heating results in $<$ 0.1 inch of TPS.

Agreement is acceptable; no TPS impact.

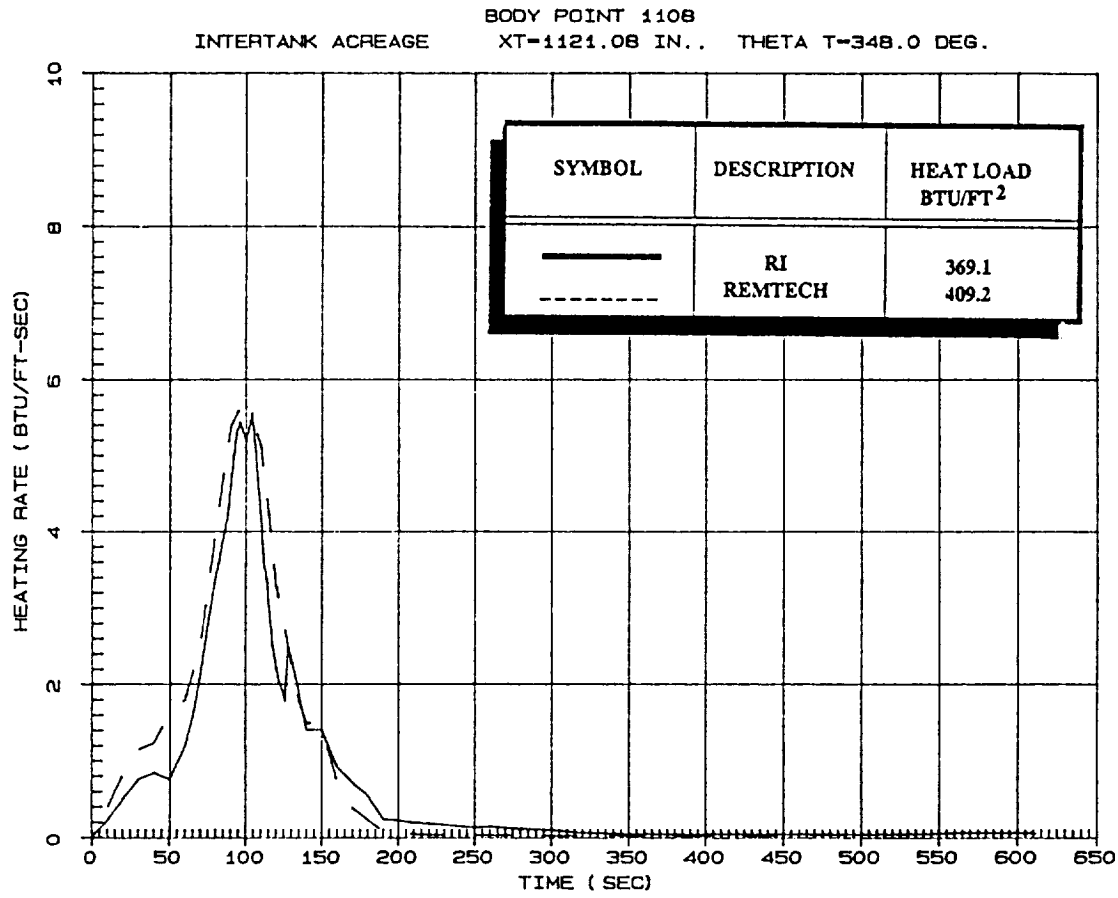


Agreement is acceptable; no TPS impact.

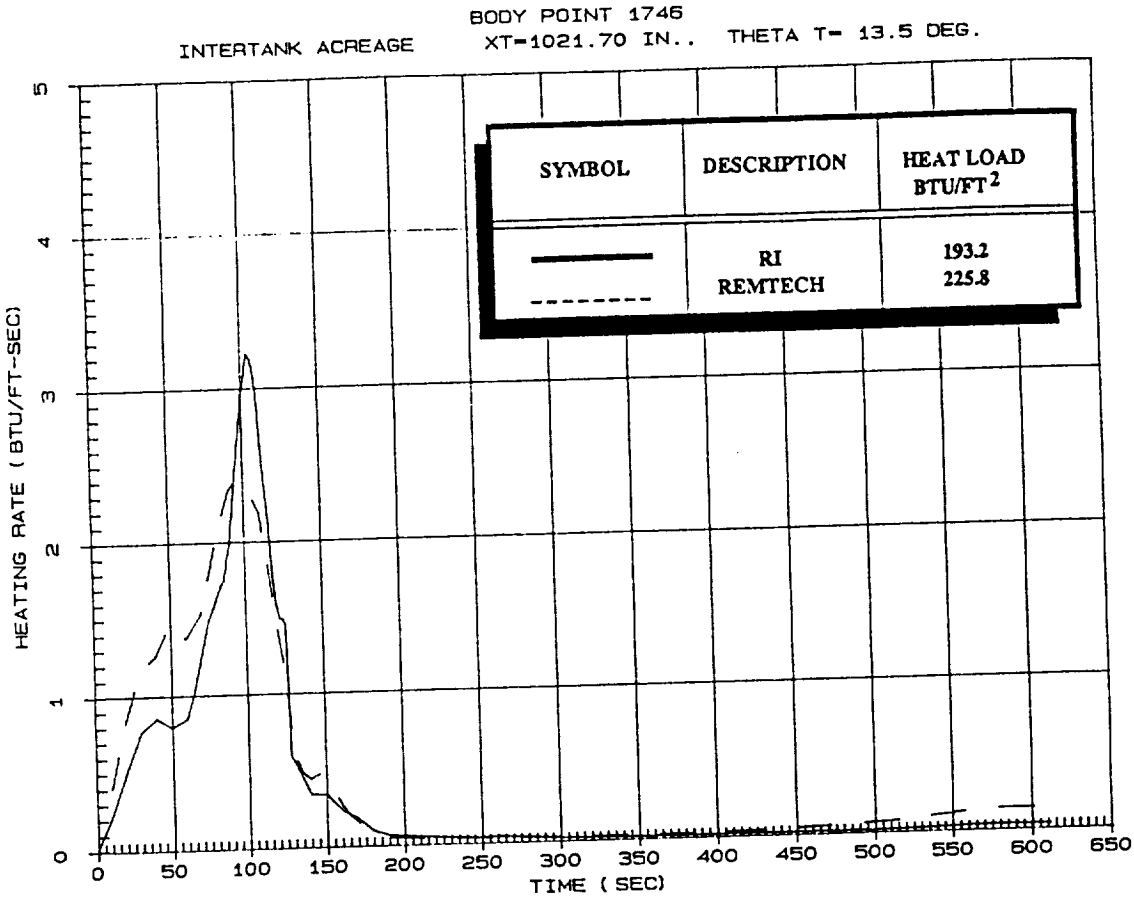


- Difference in heating results in < 0.1 inch of TPS.

Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



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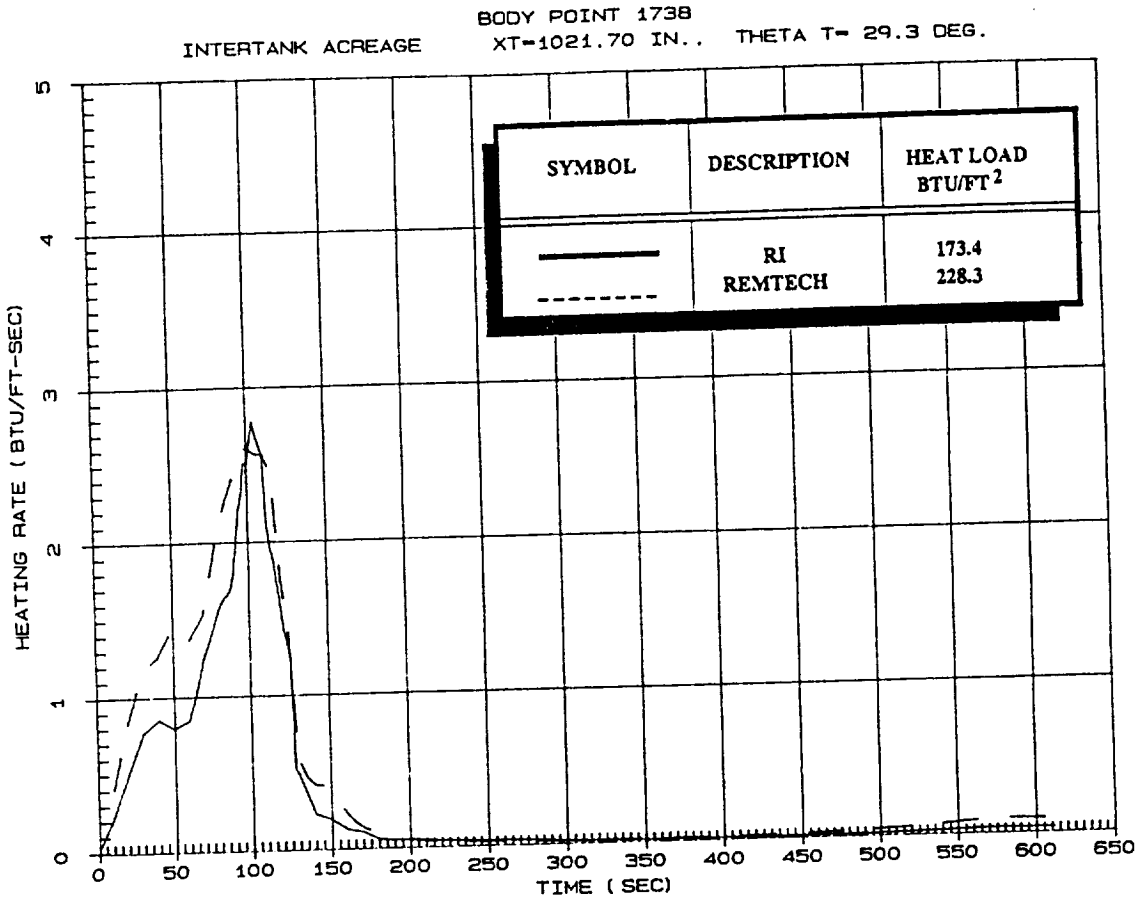

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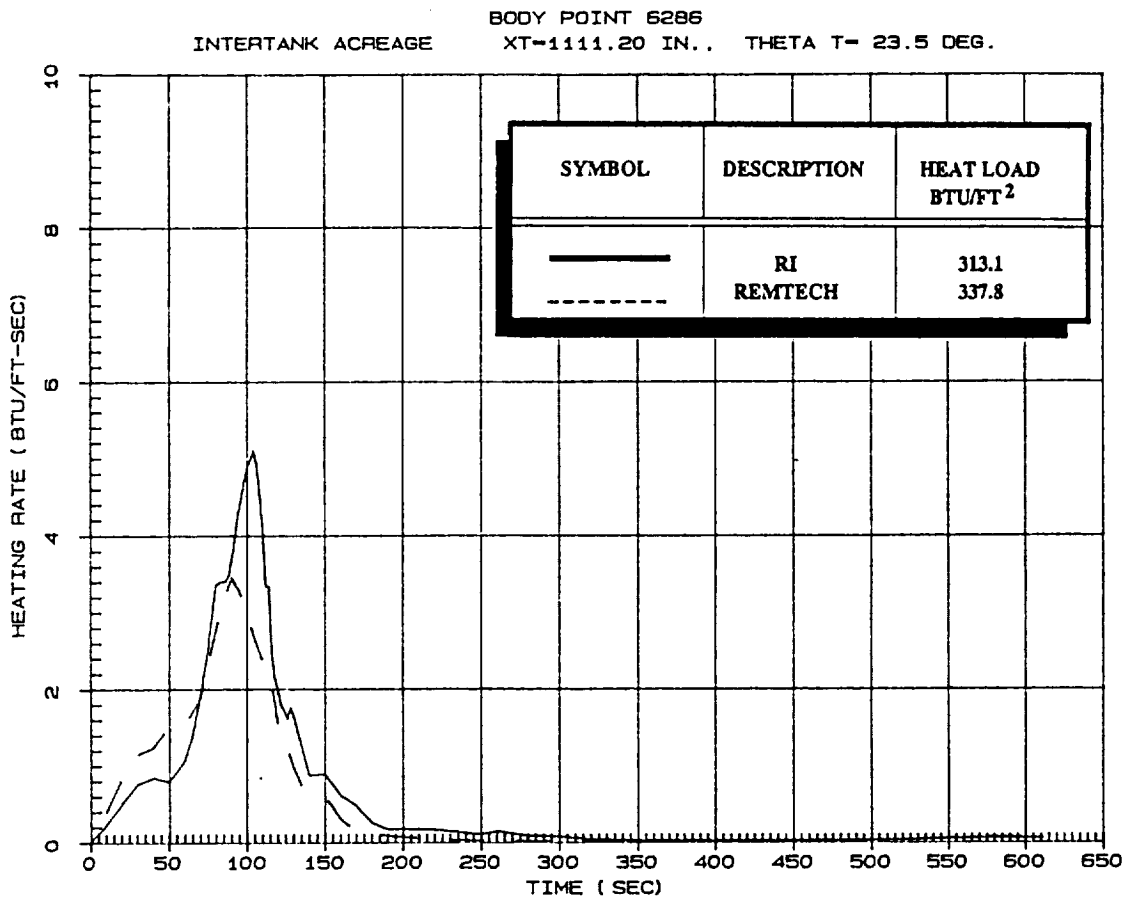

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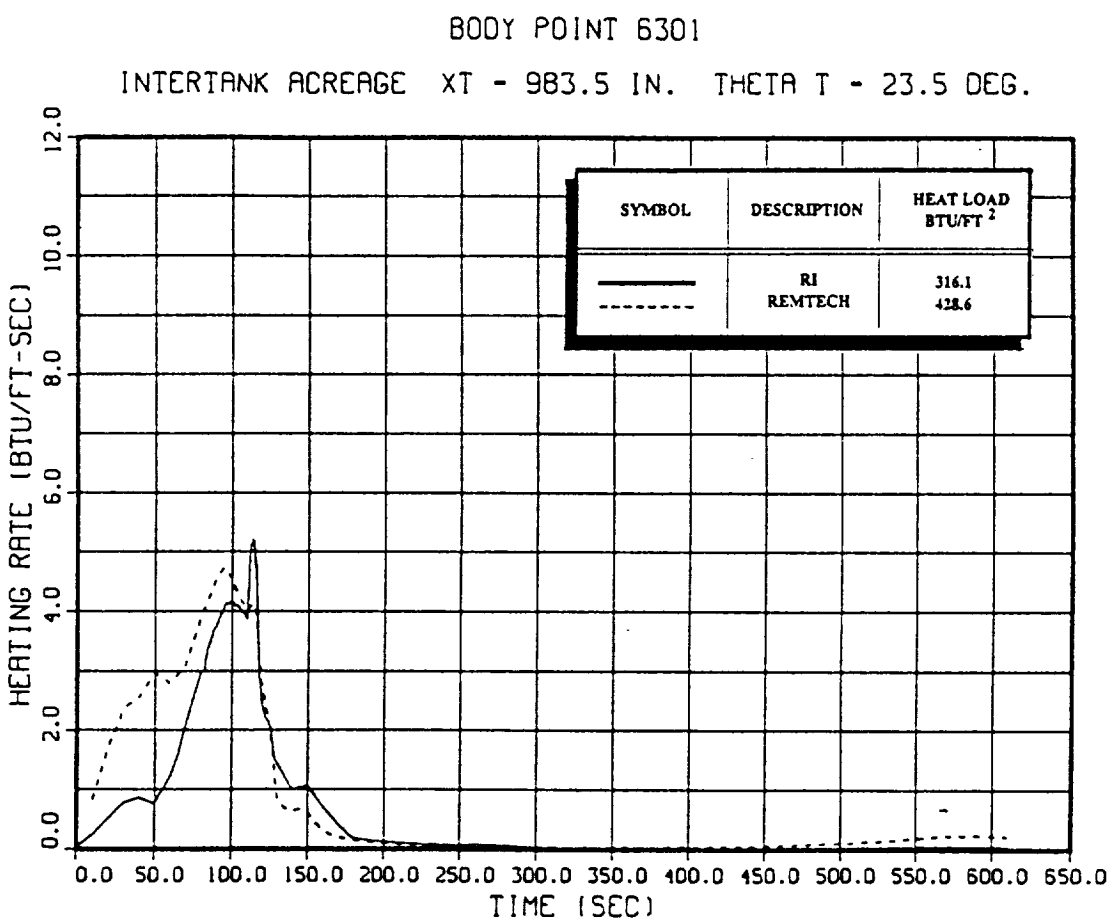

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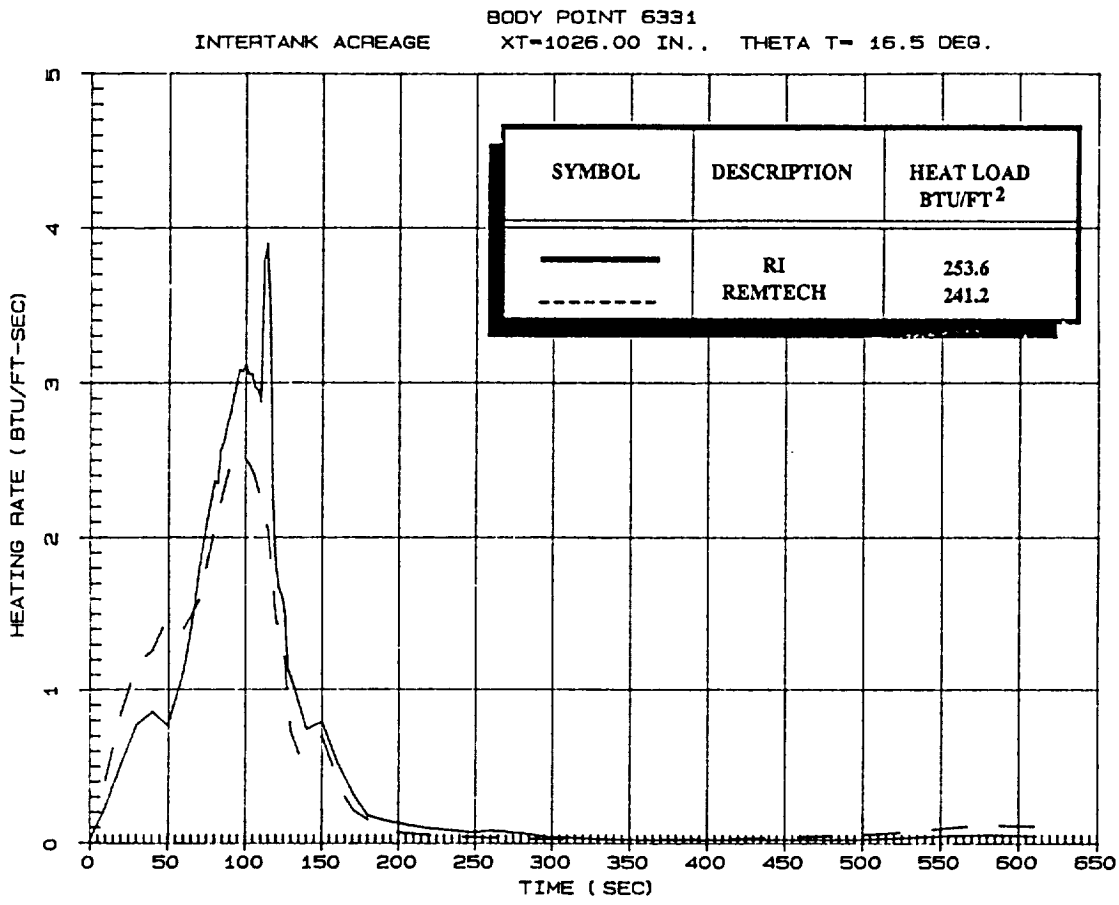

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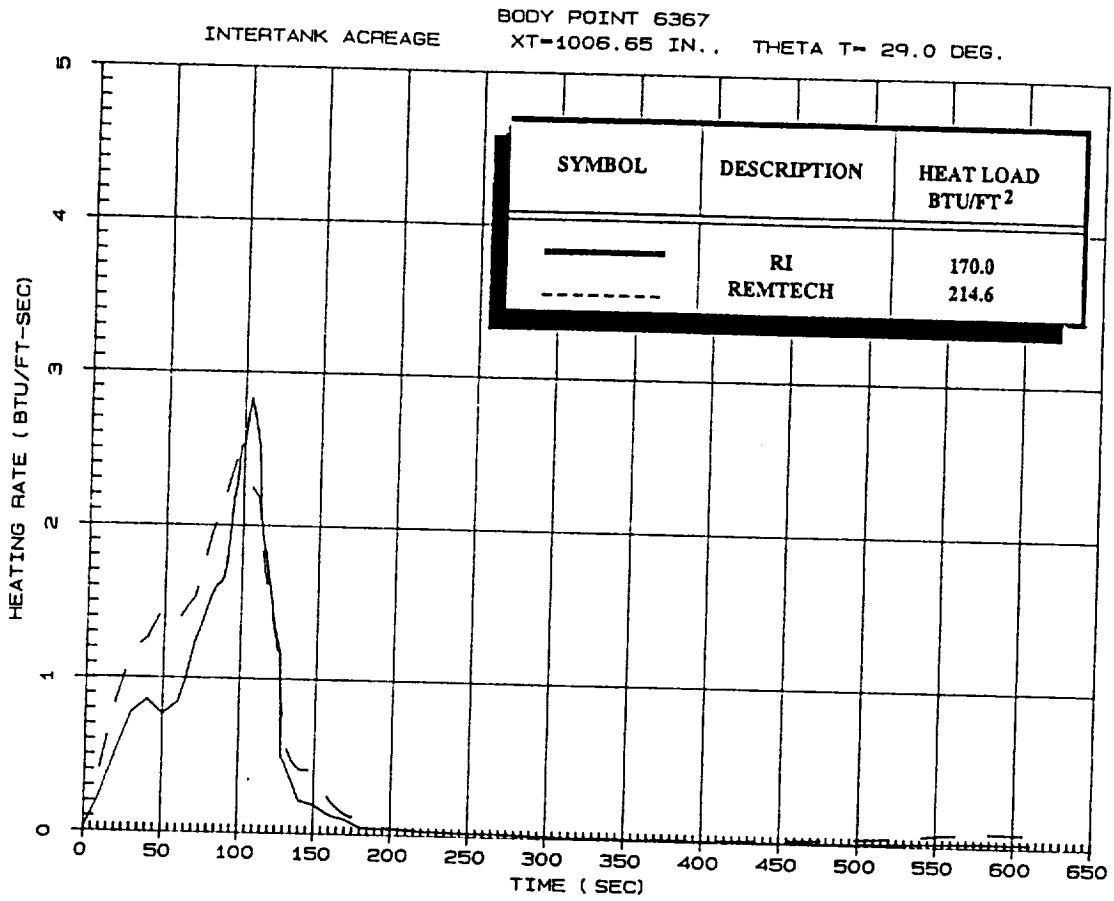

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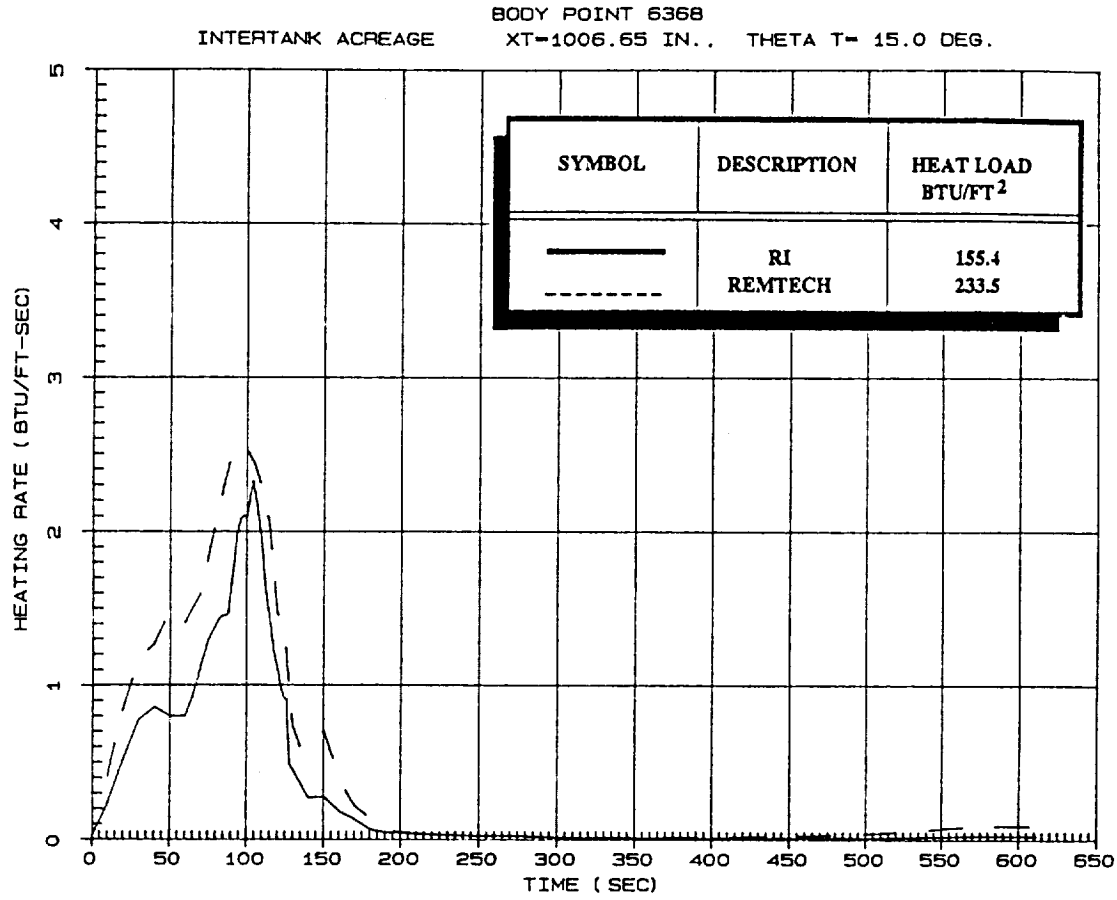

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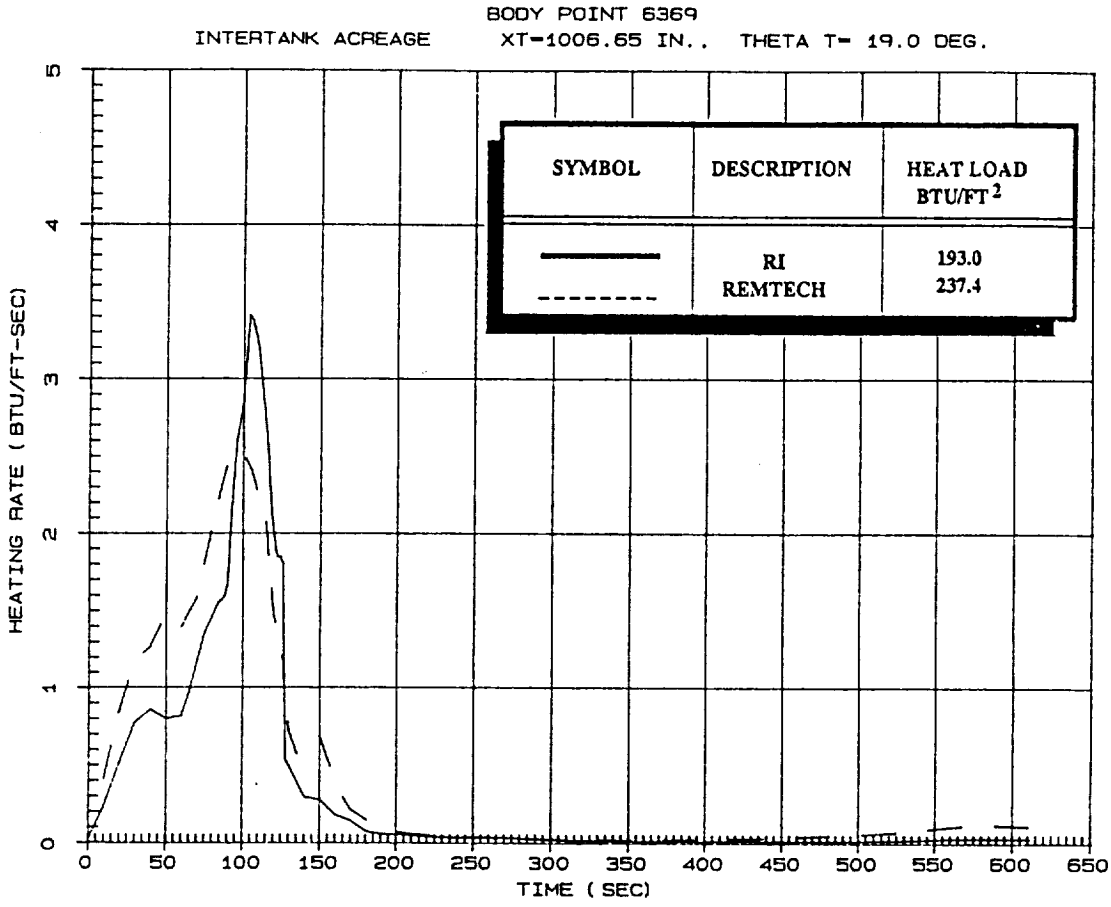

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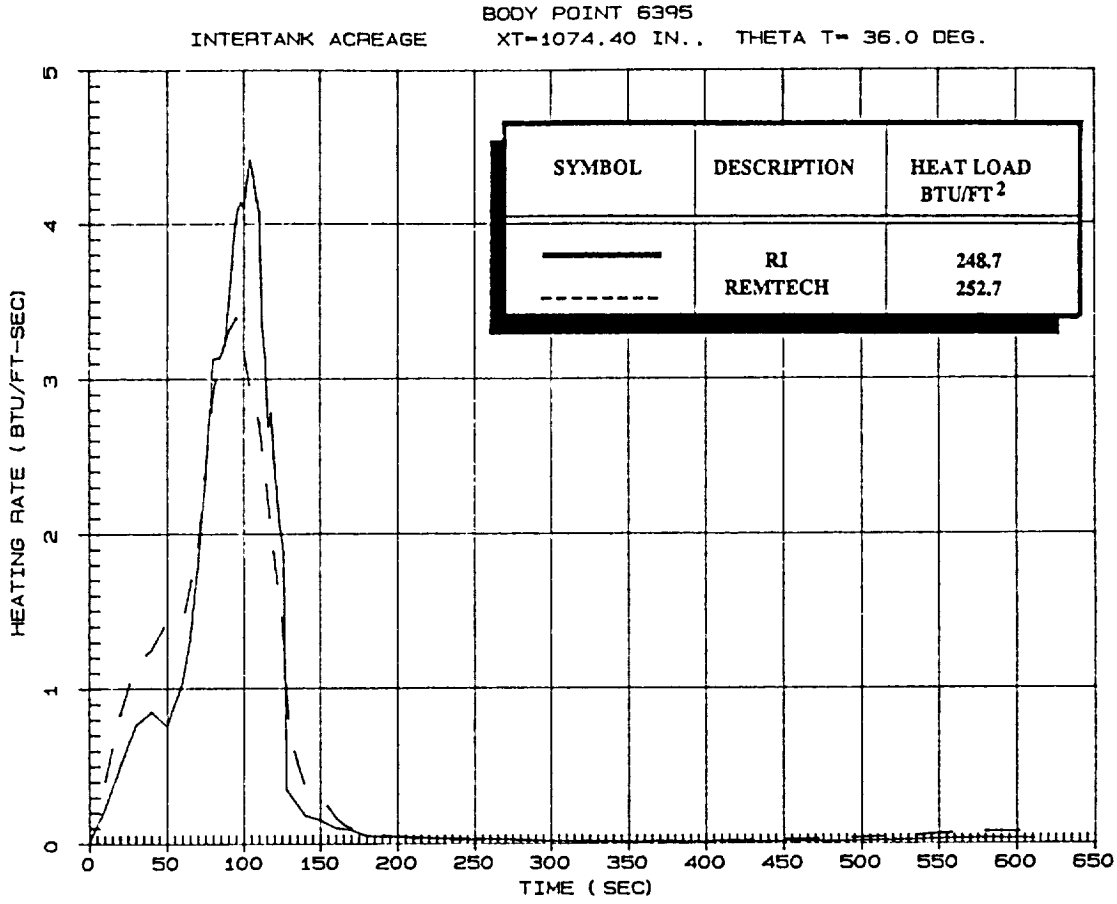

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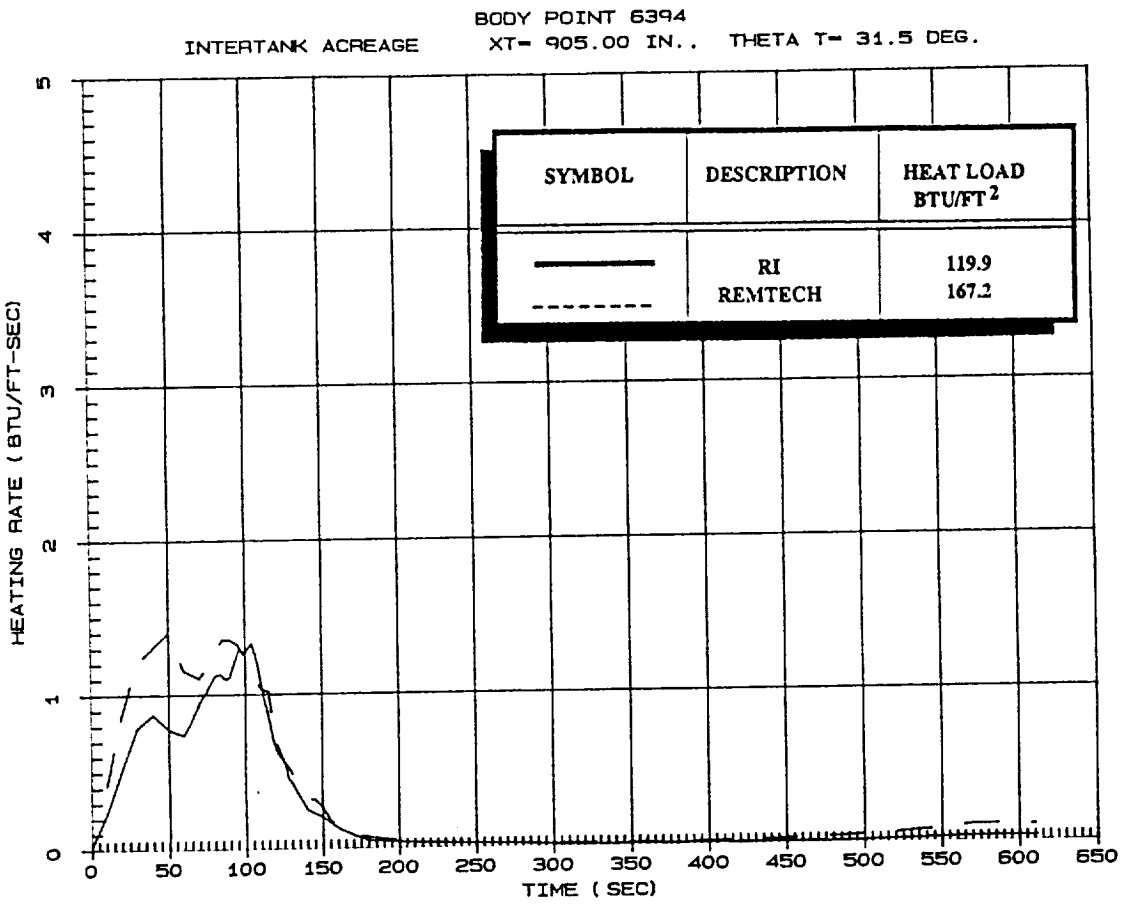

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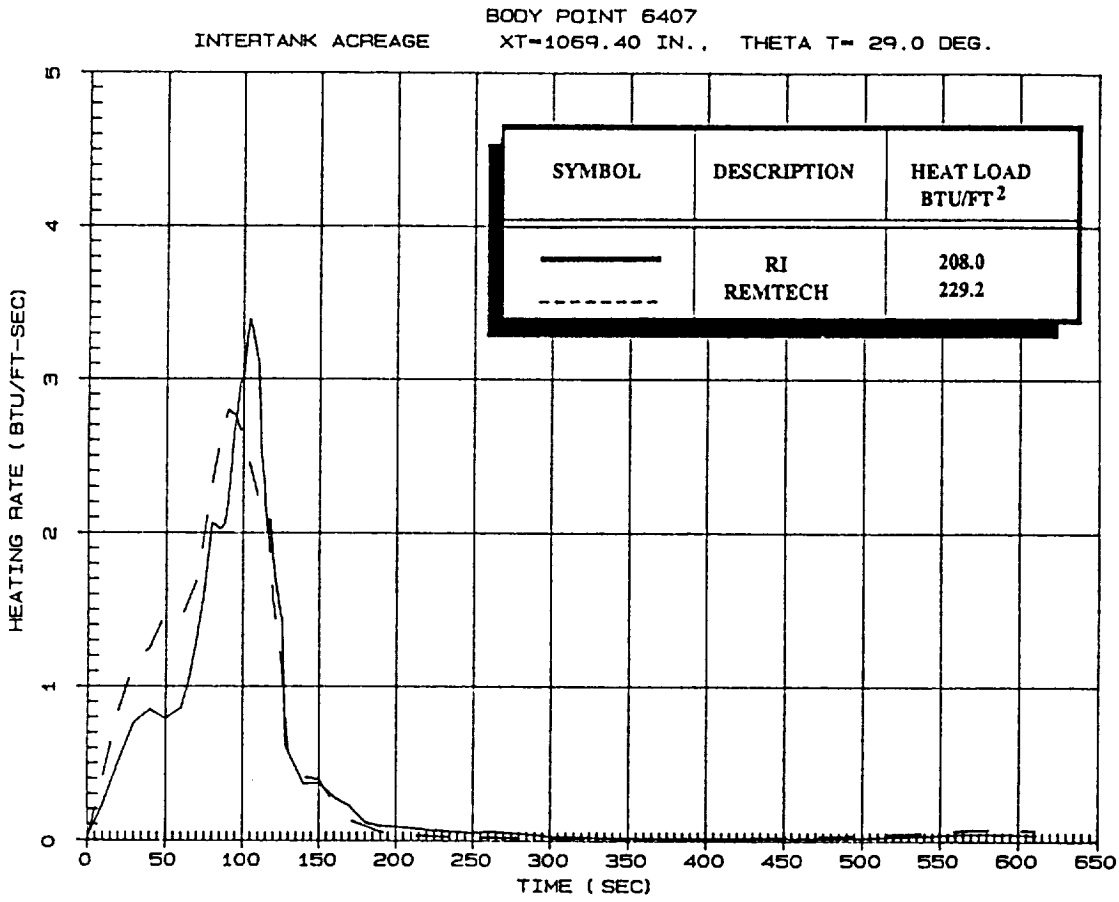

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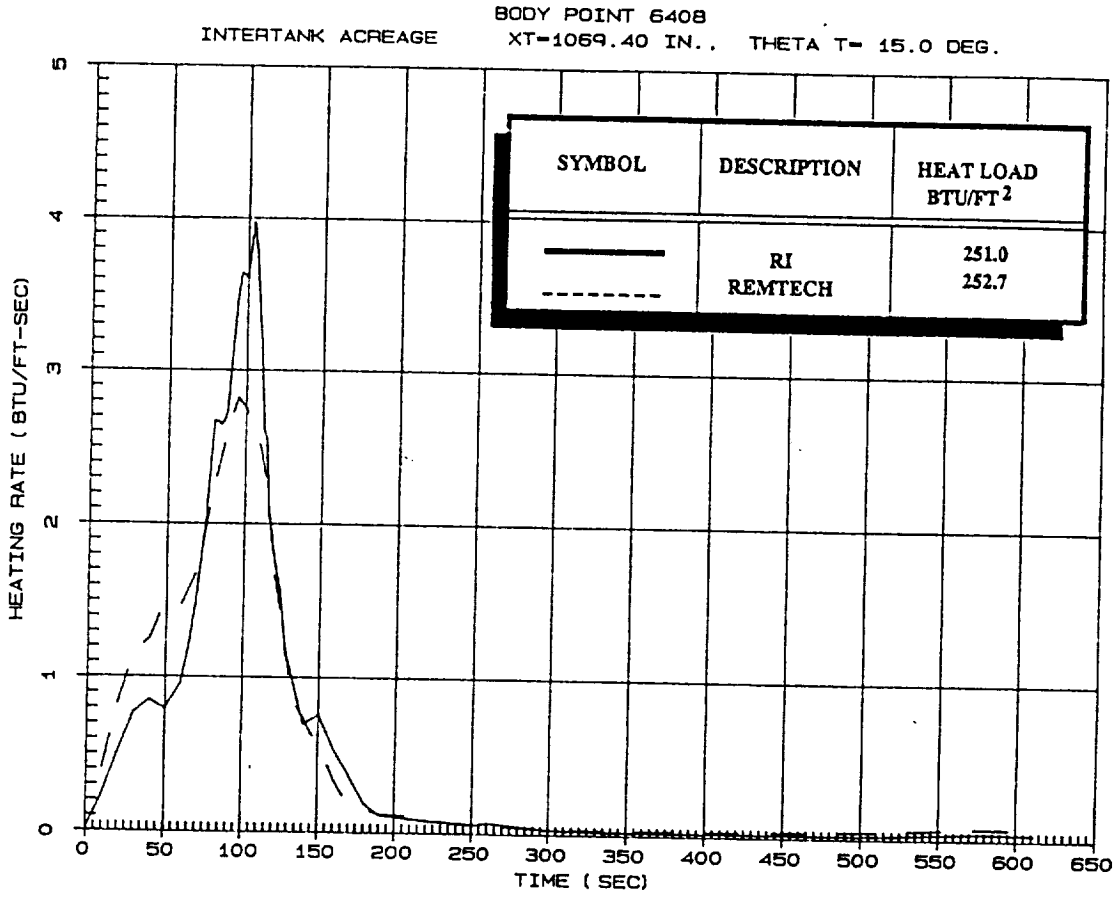

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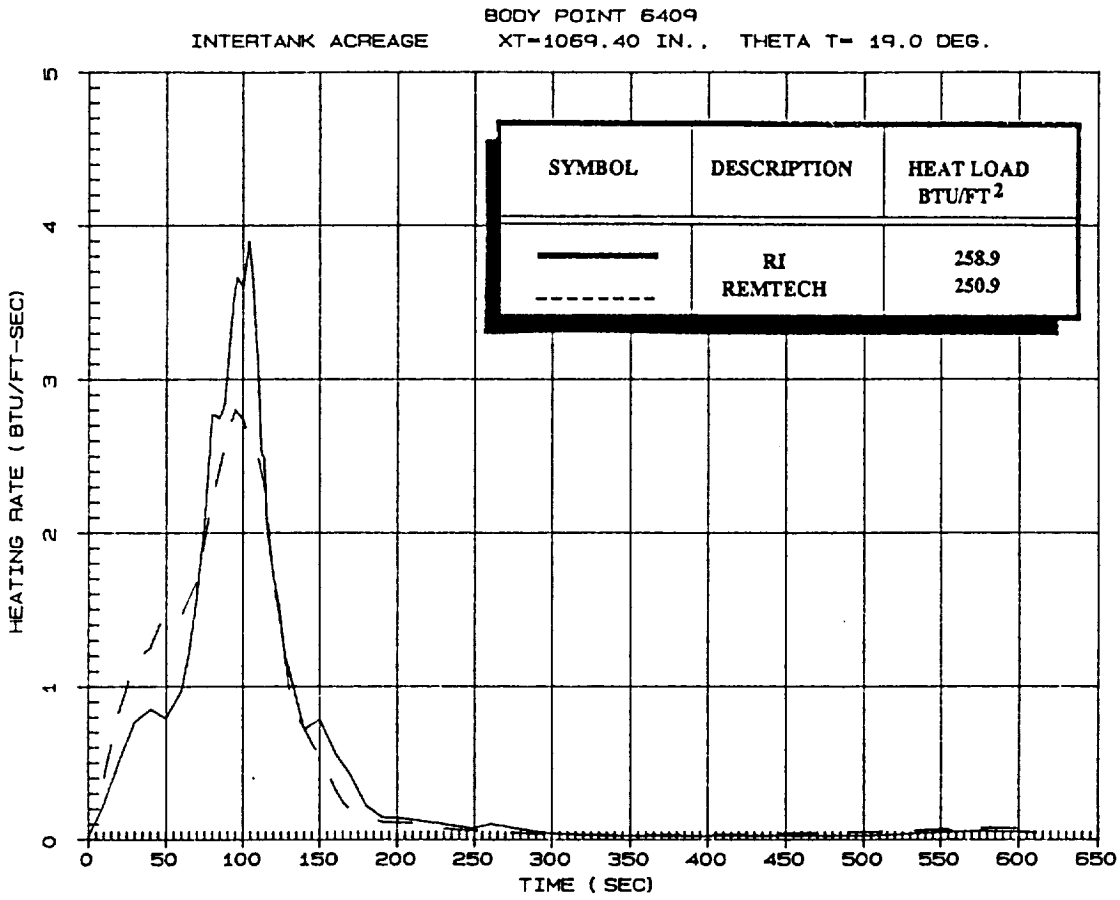

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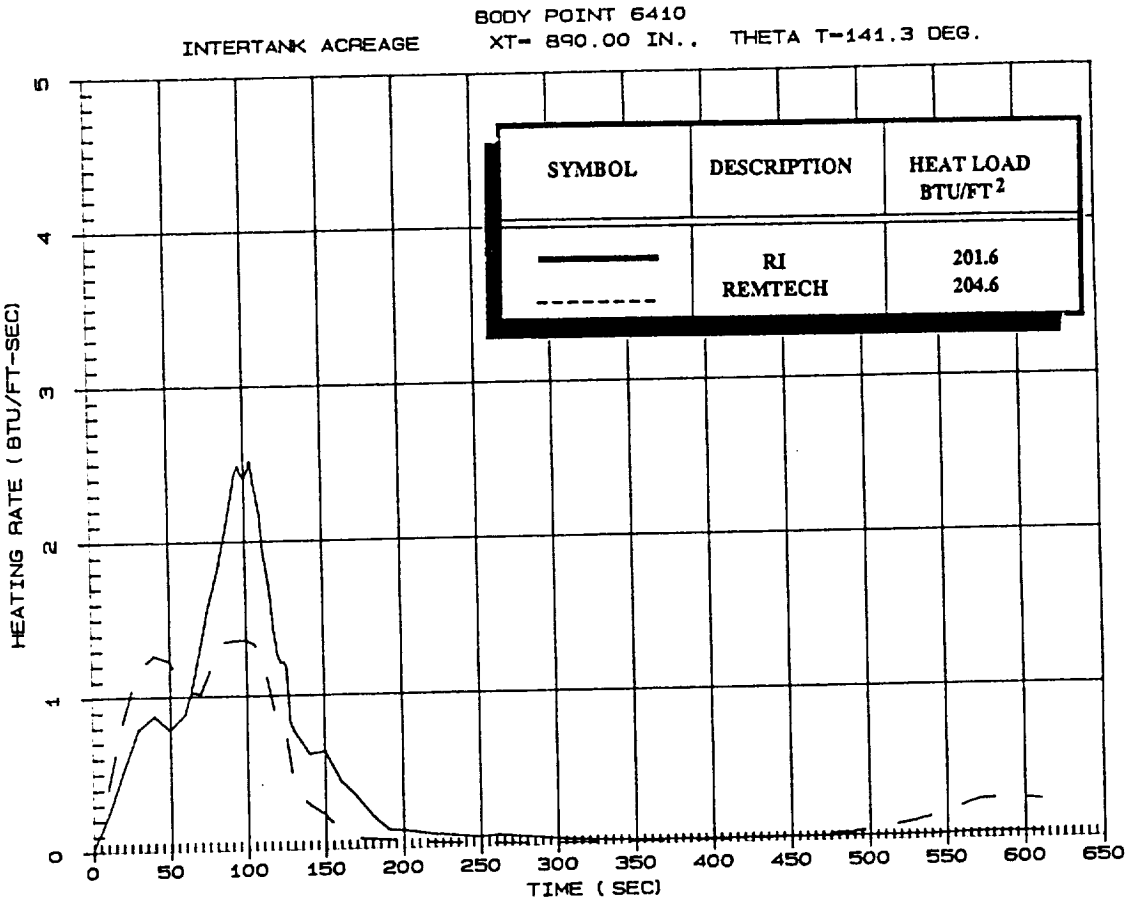

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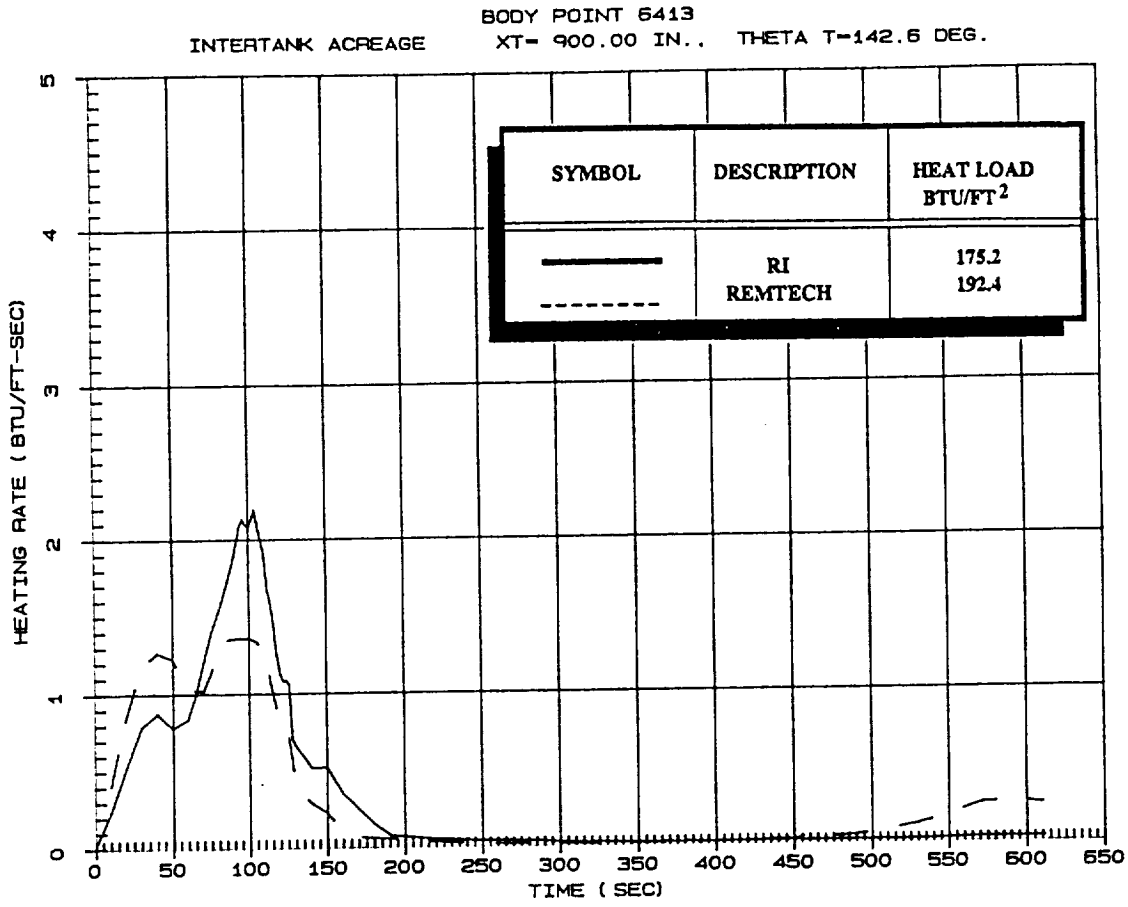

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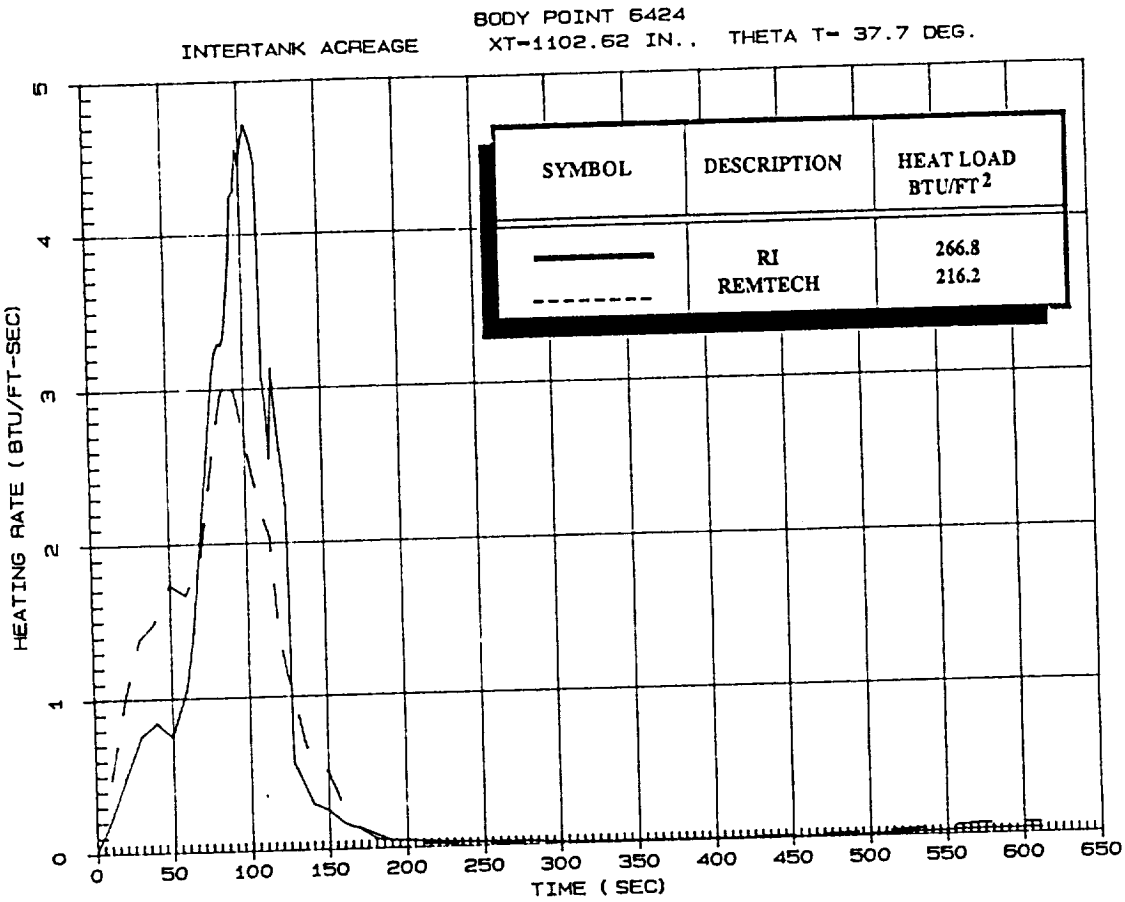

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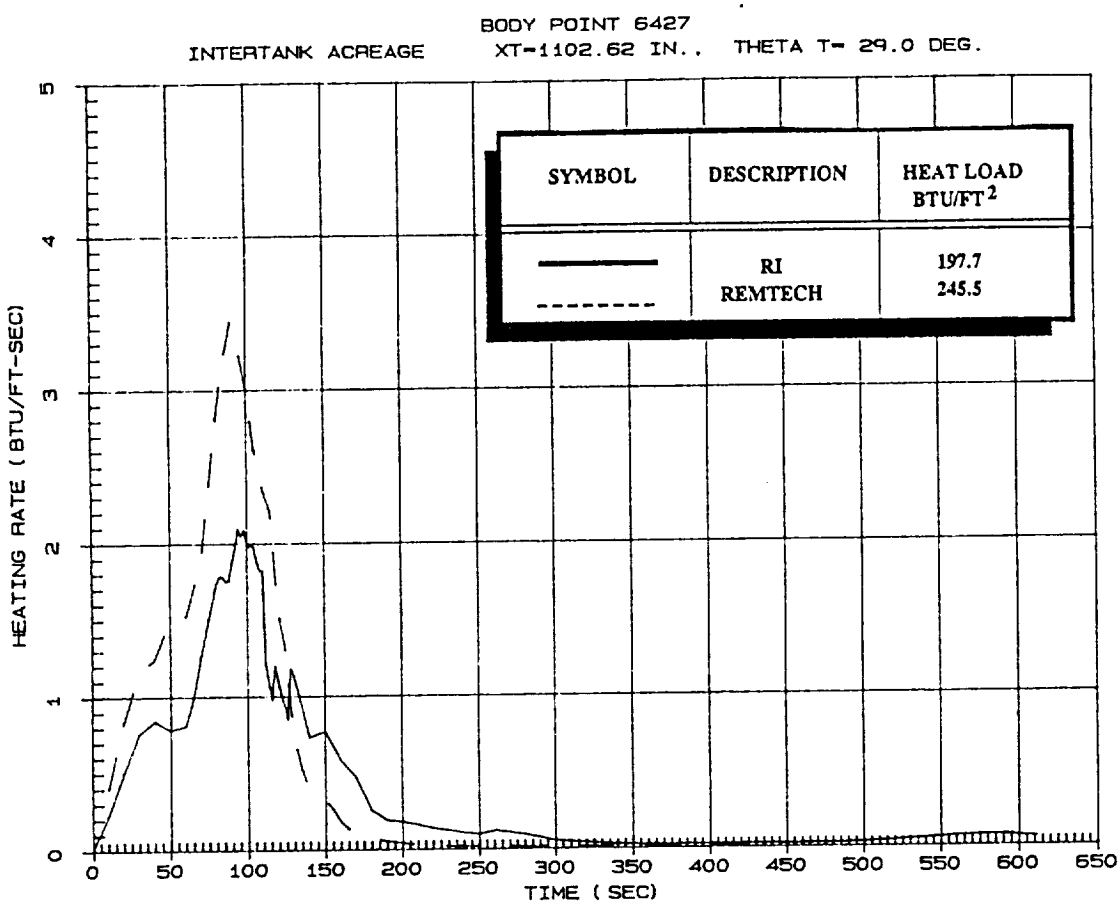

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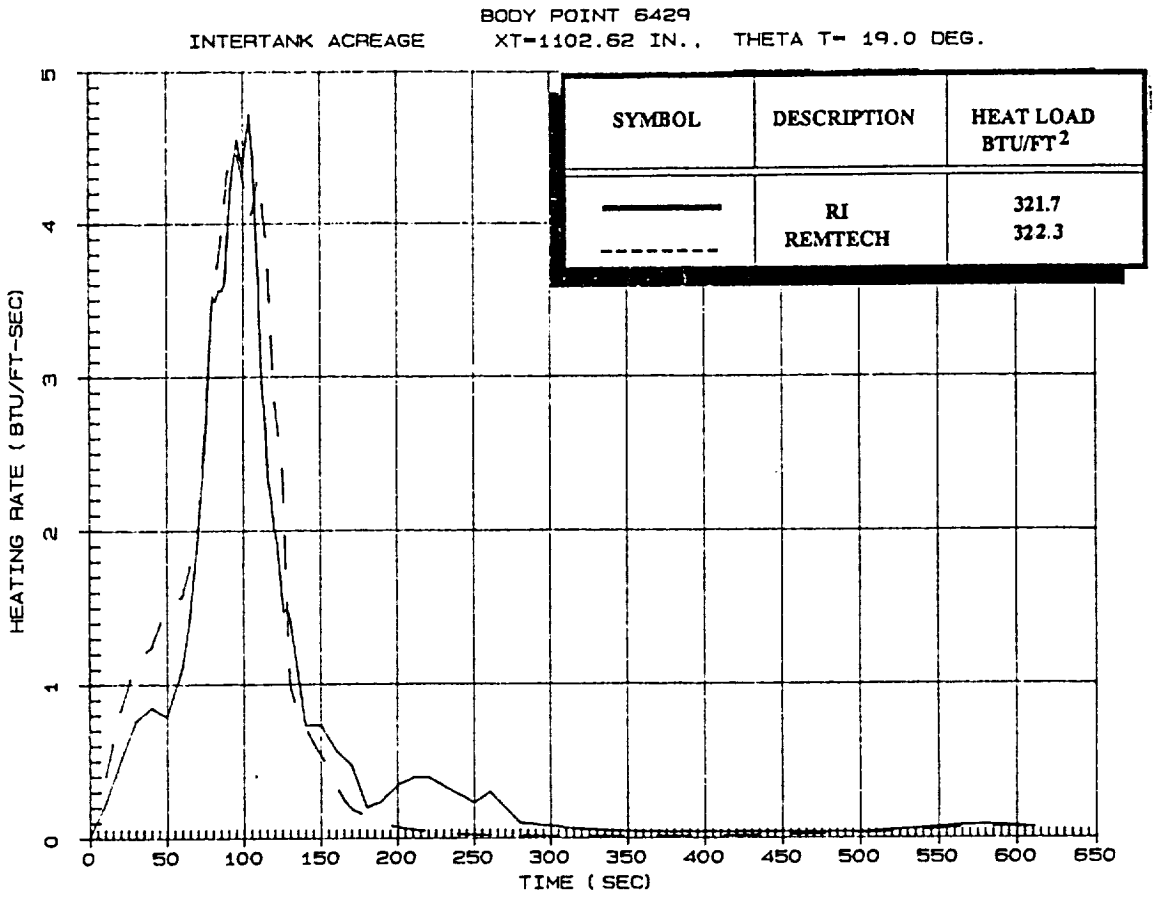

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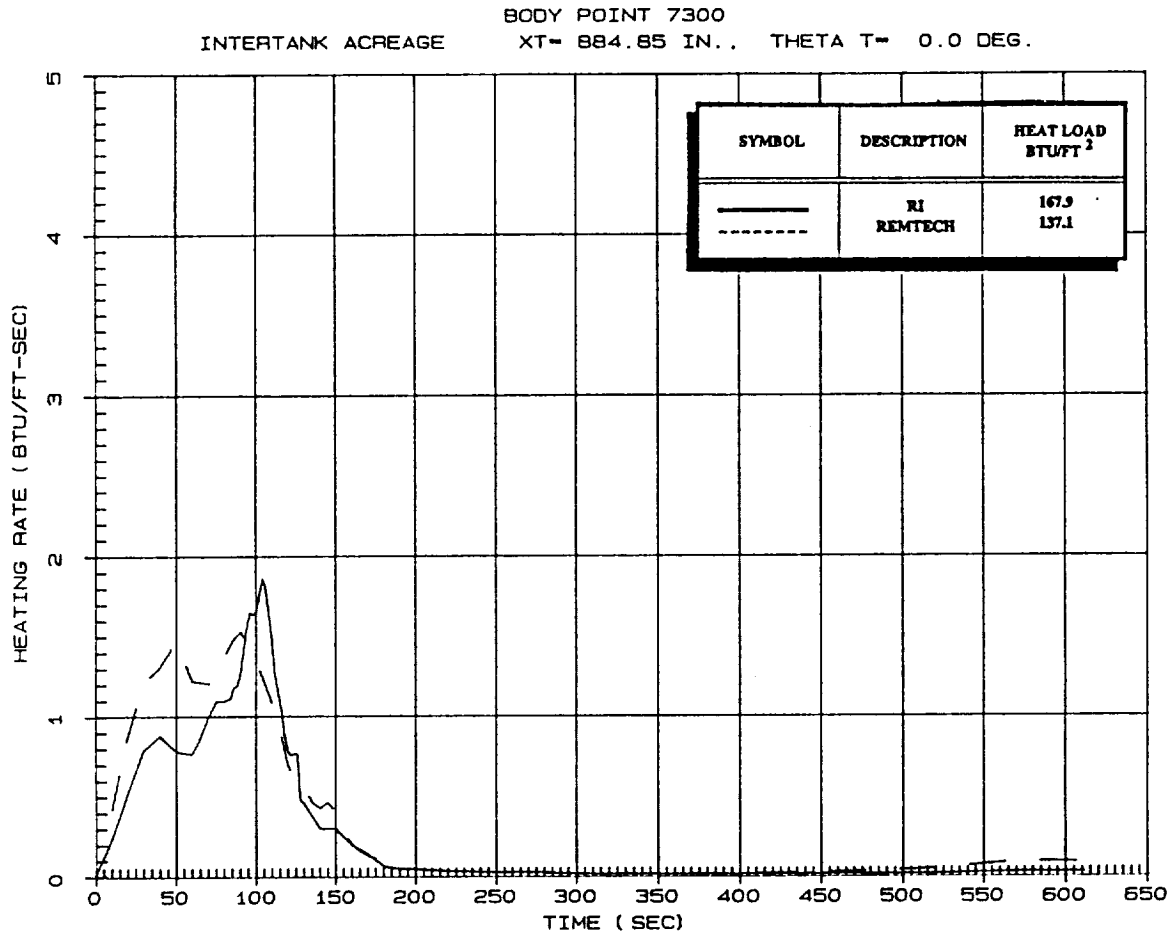

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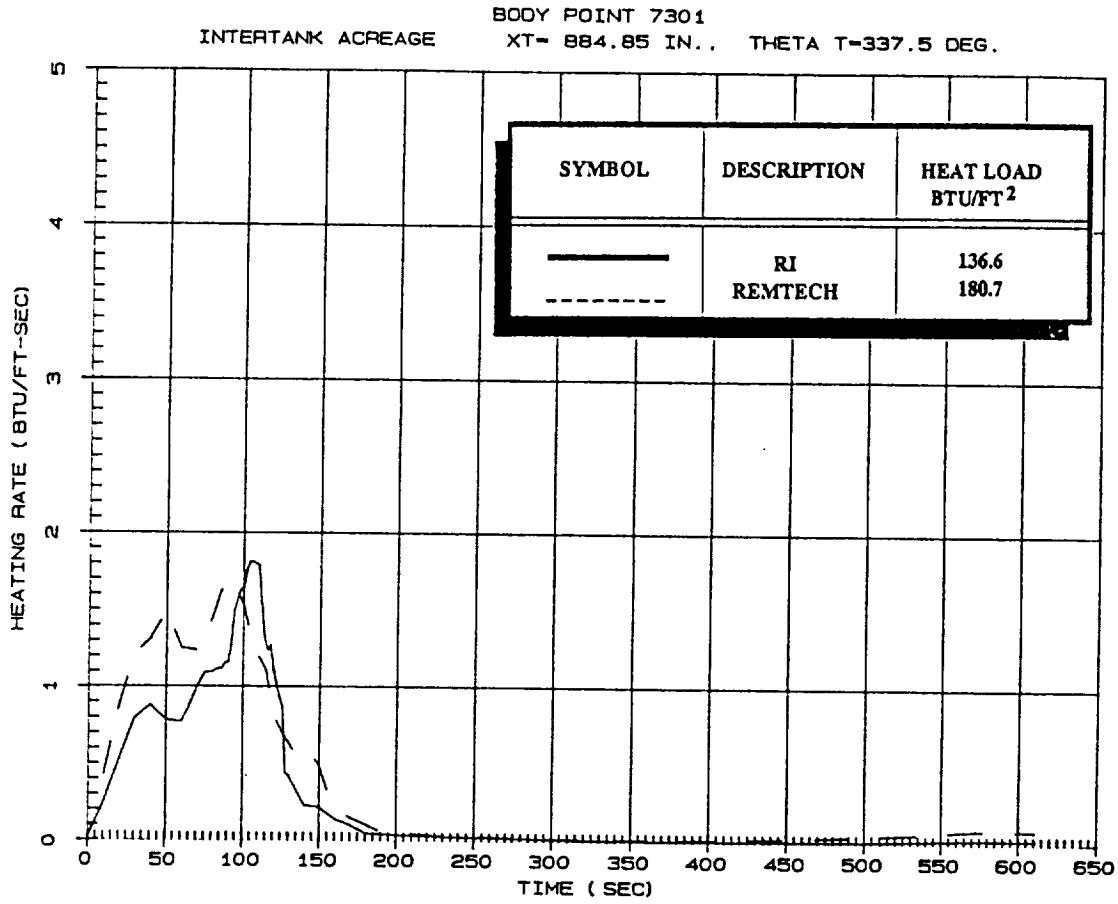

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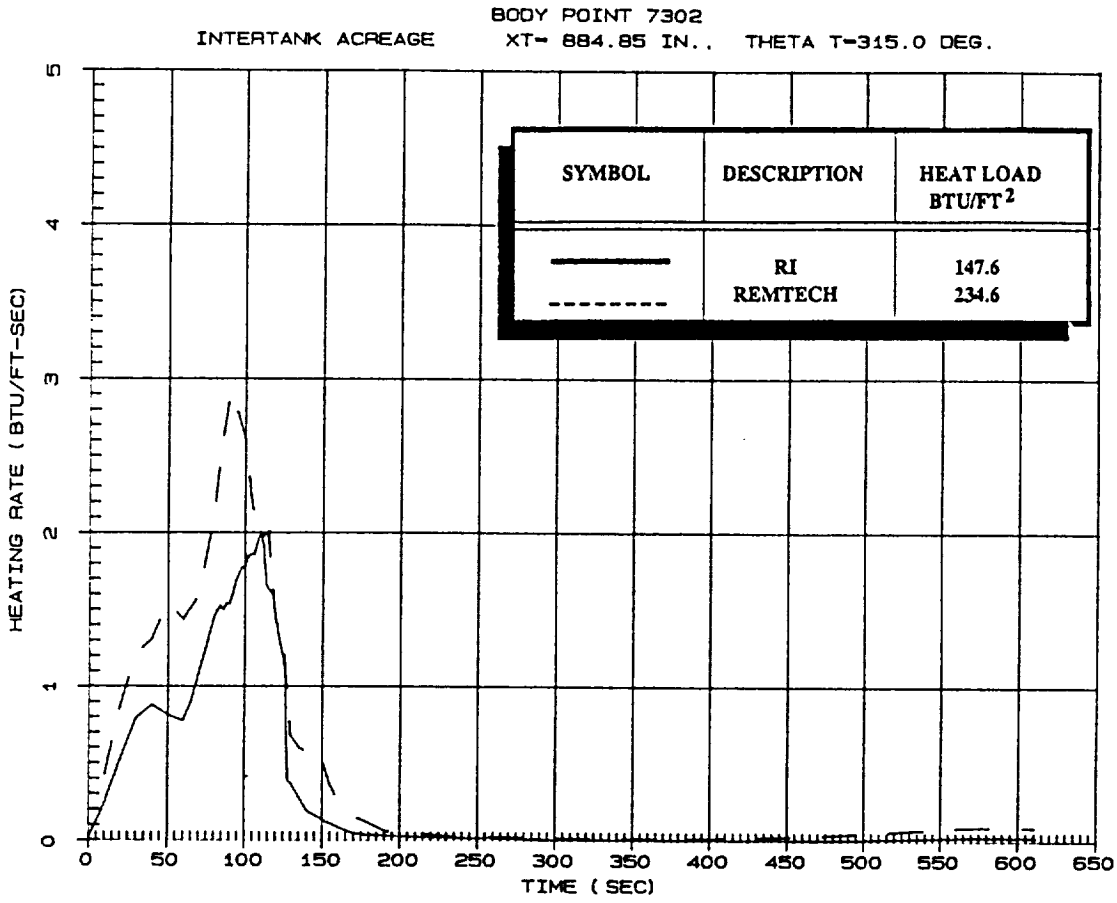

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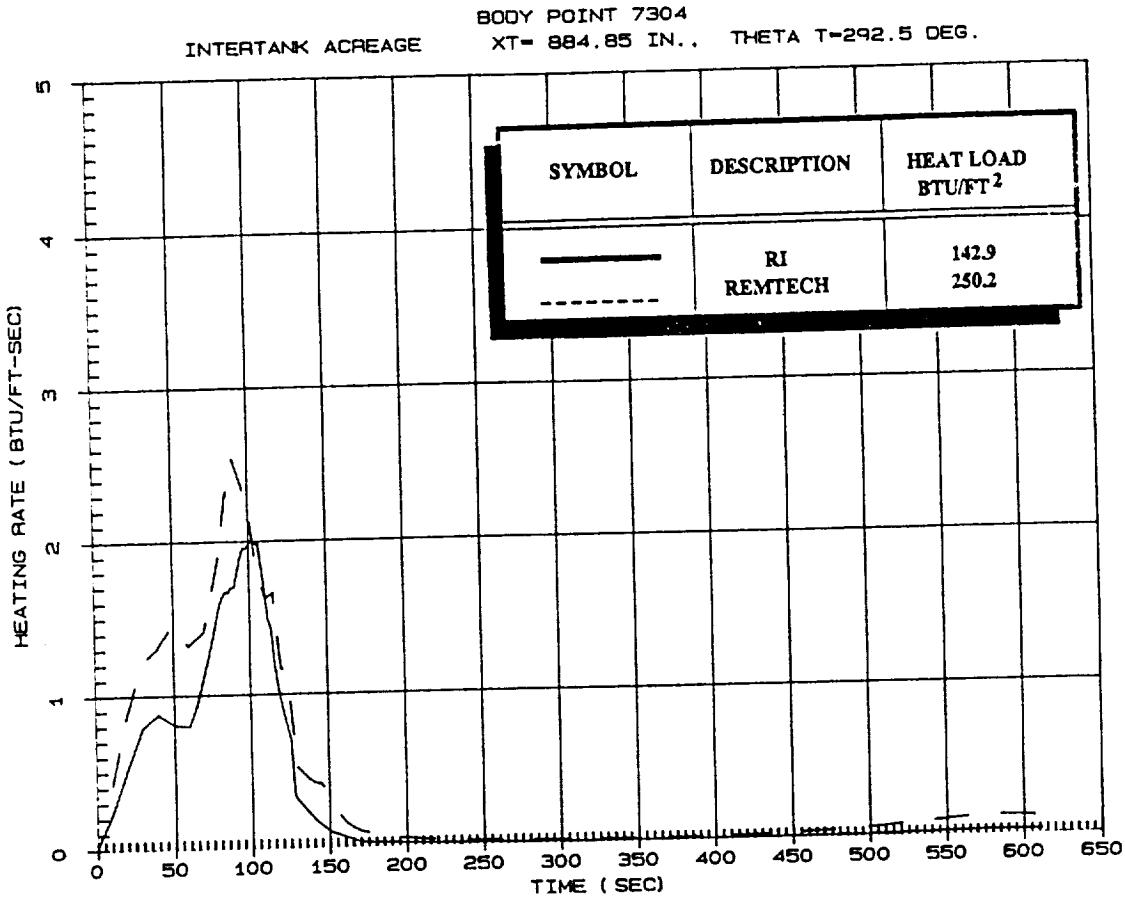

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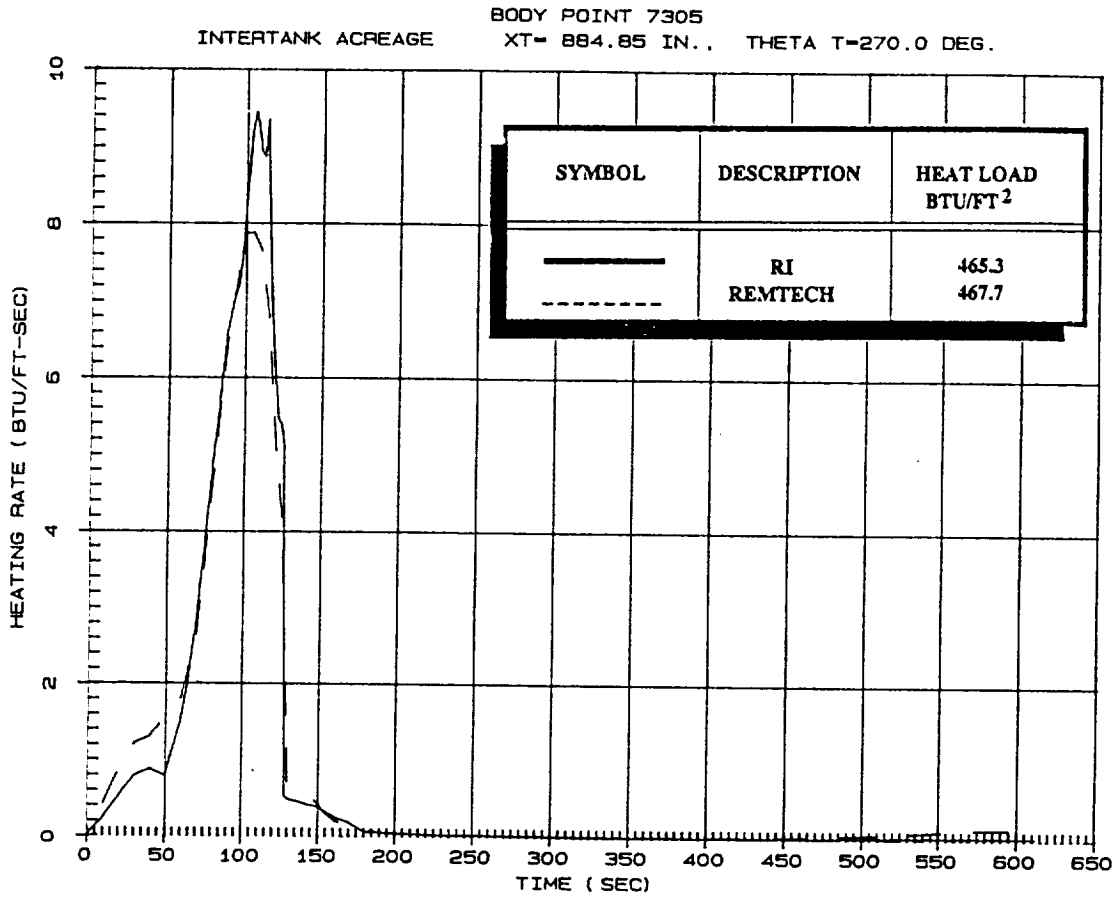

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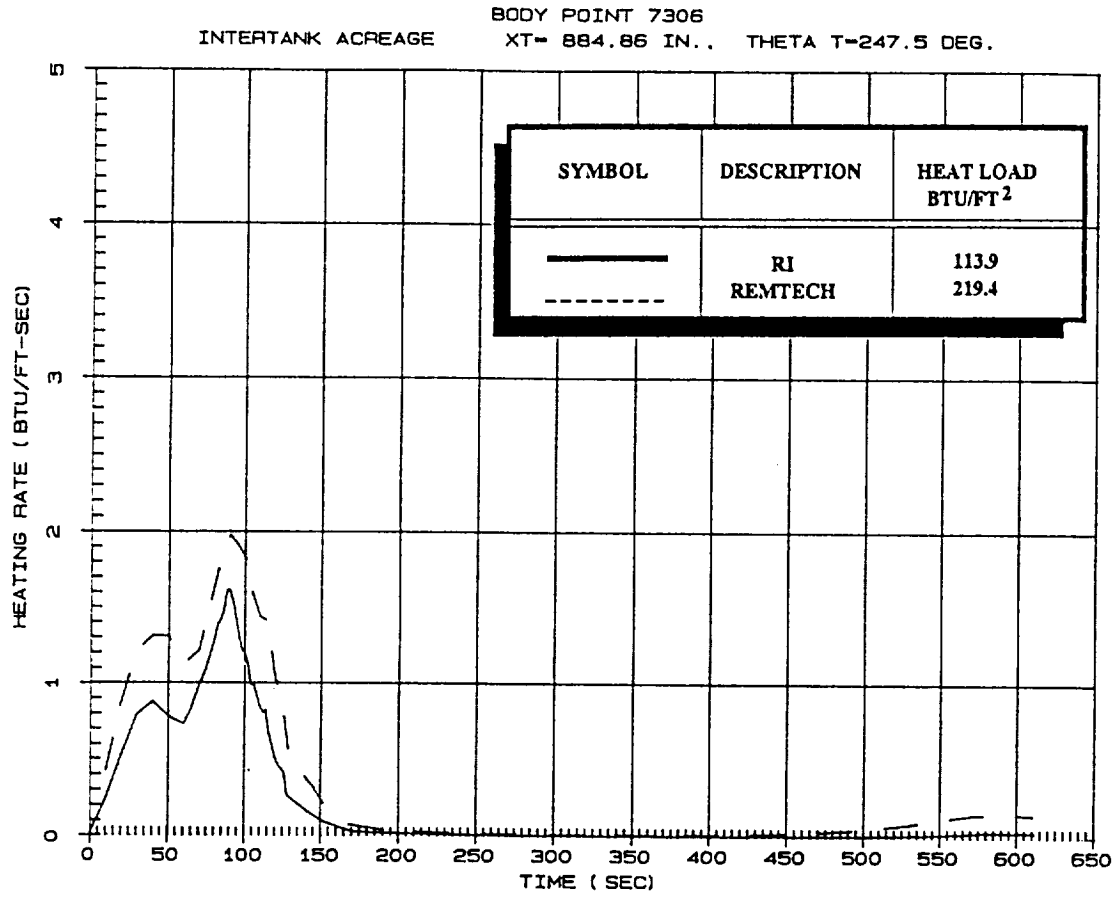

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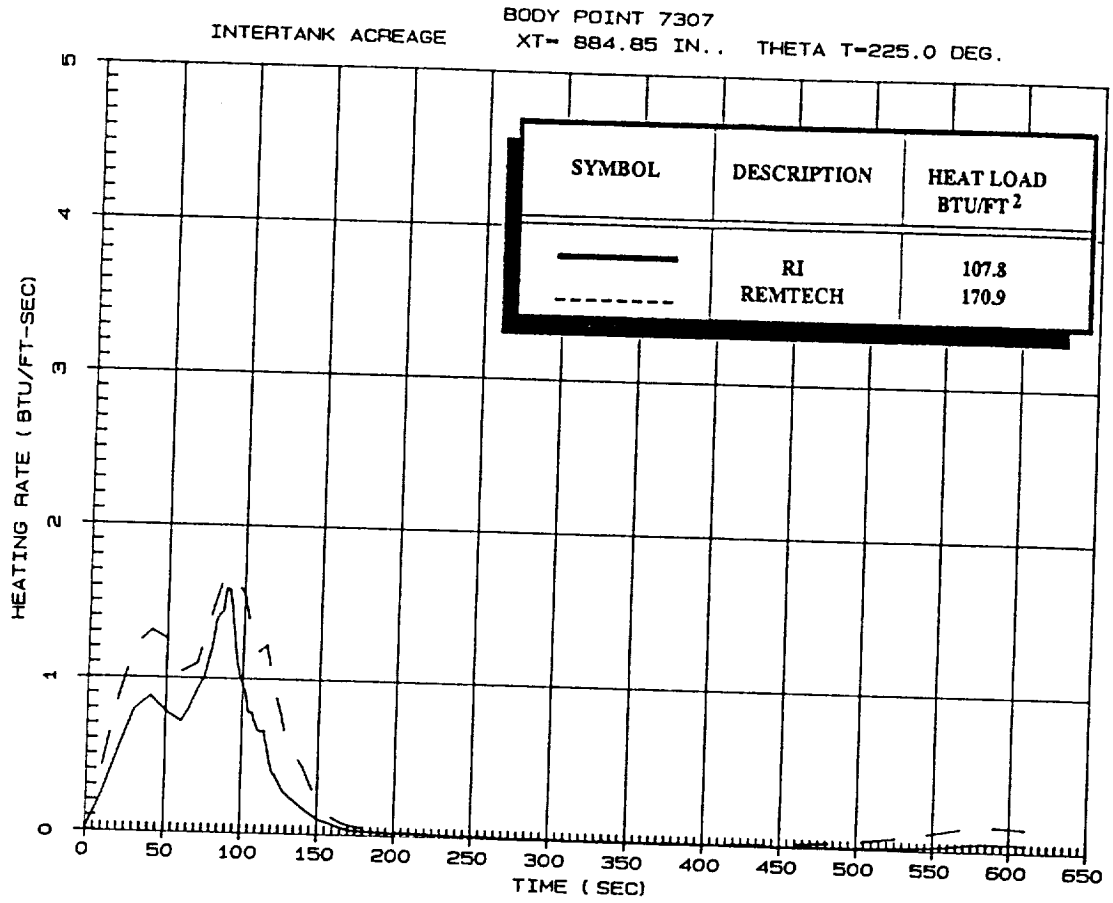

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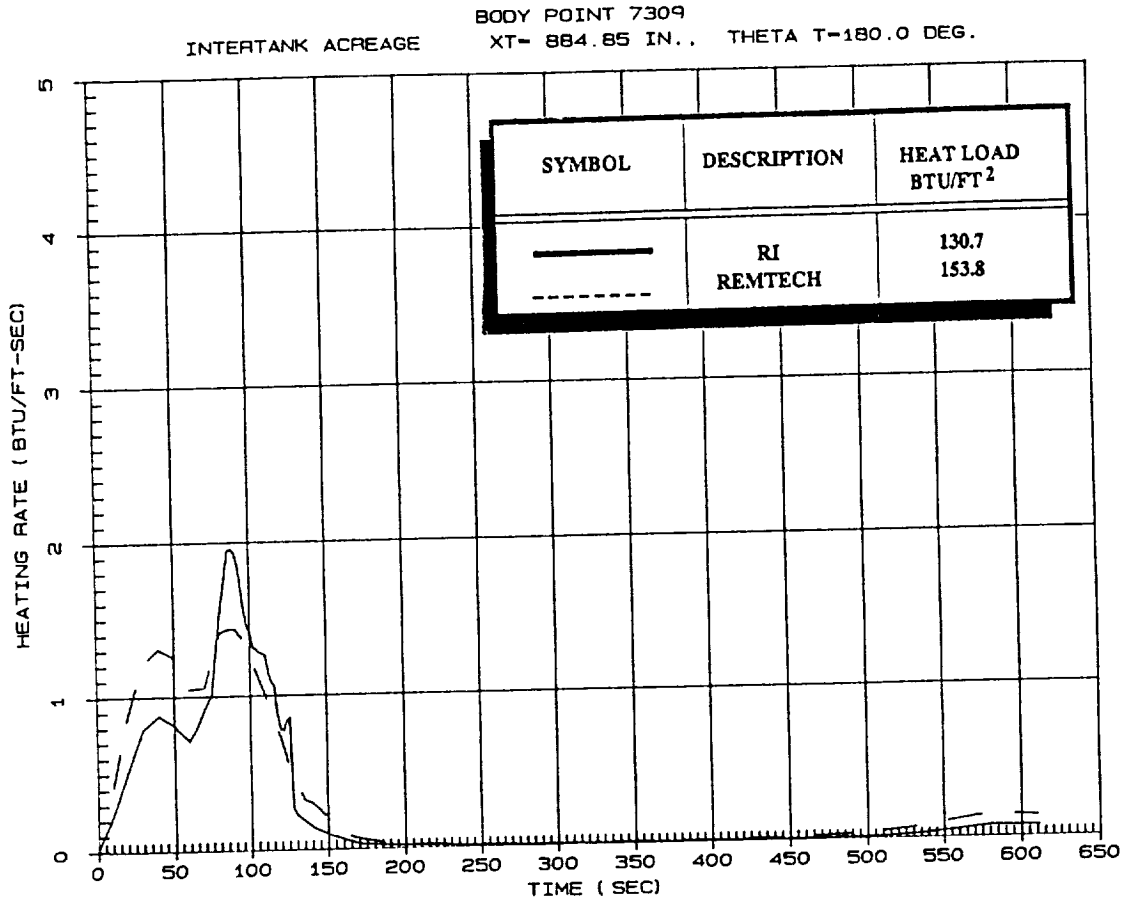

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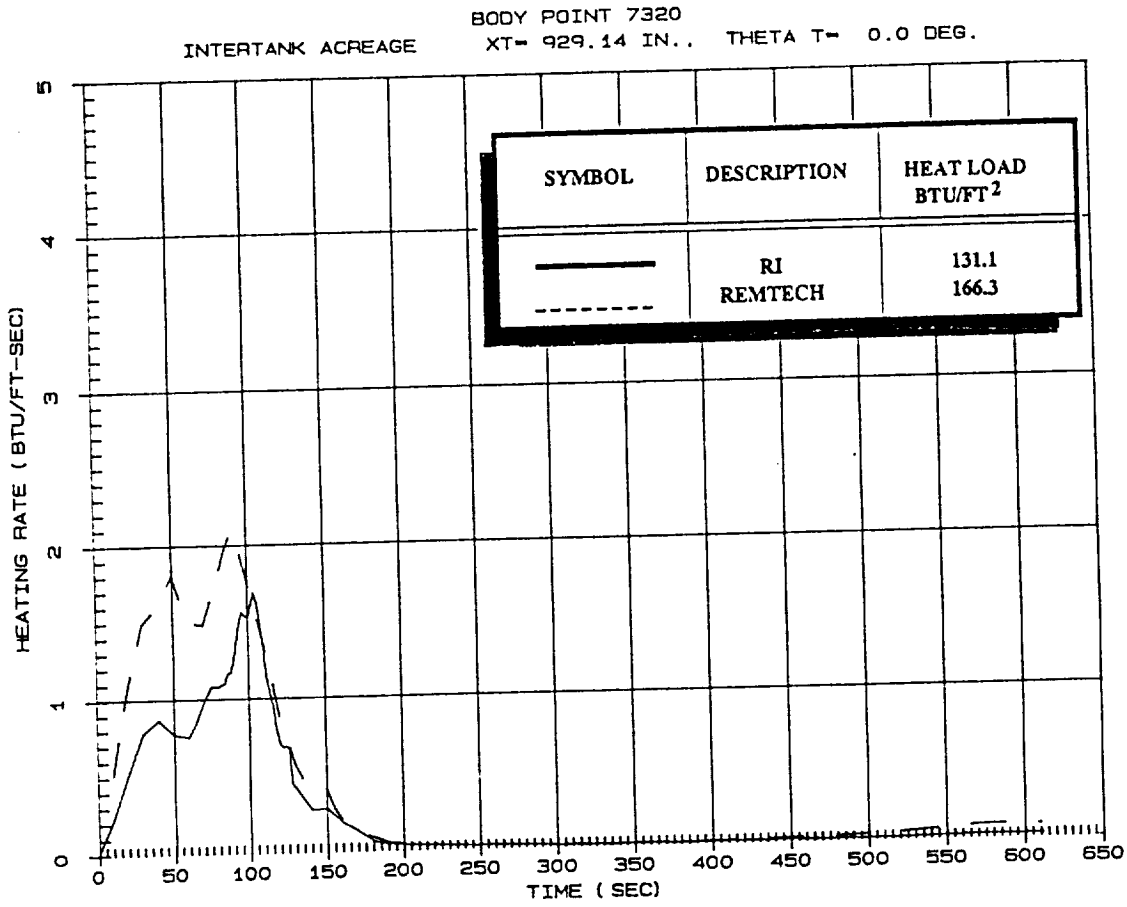

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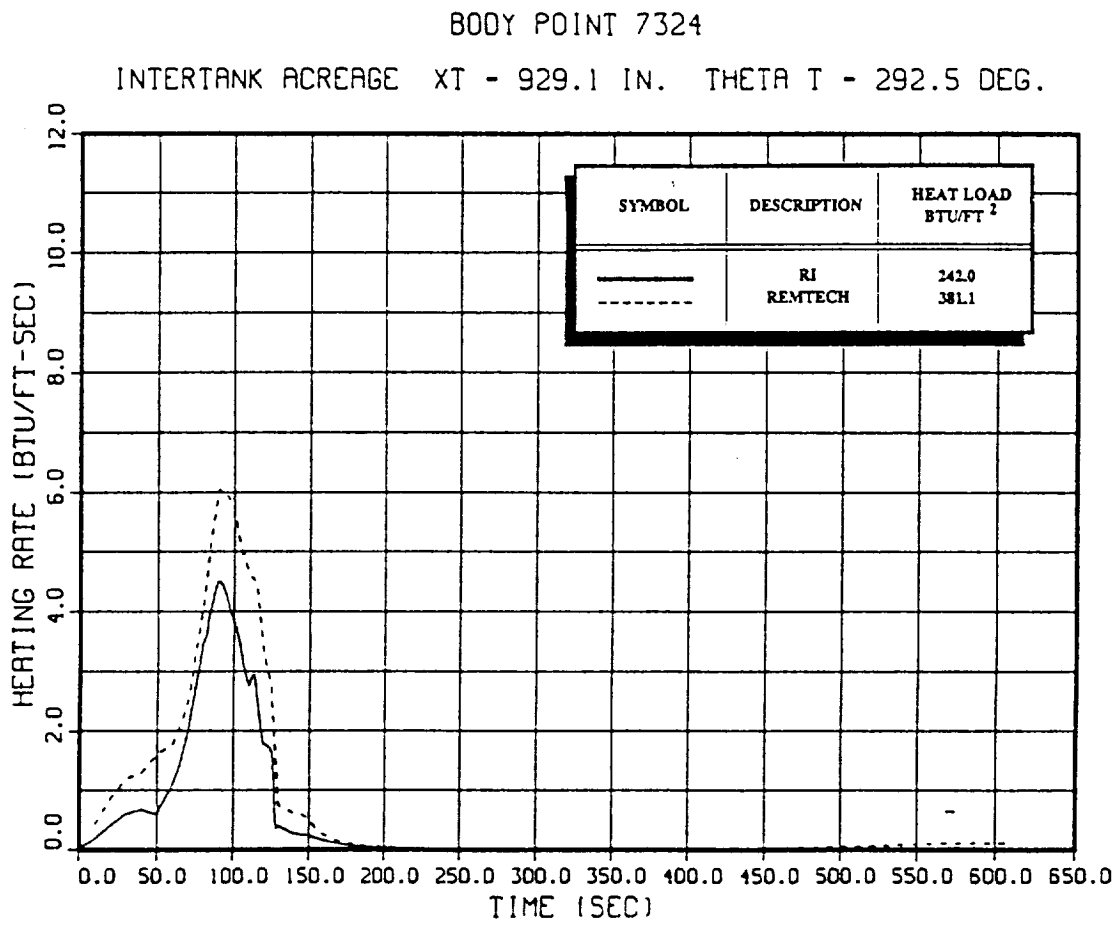

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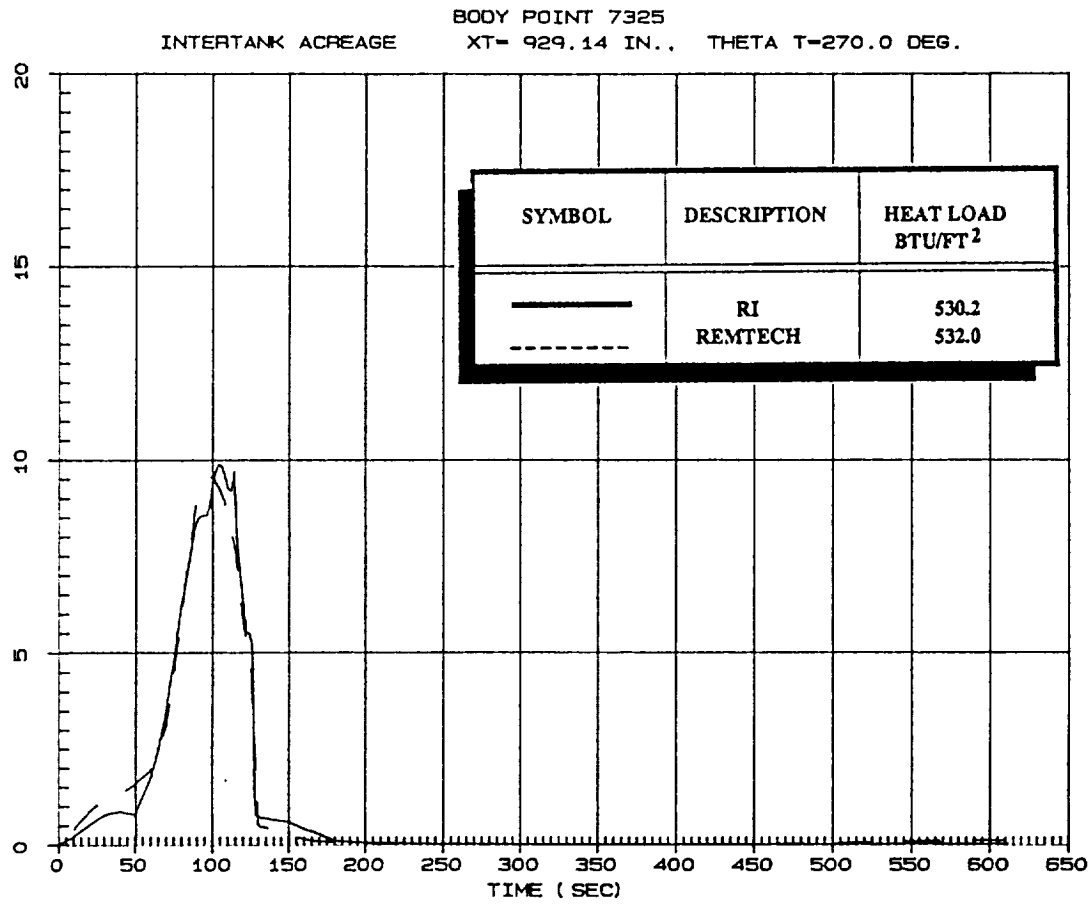

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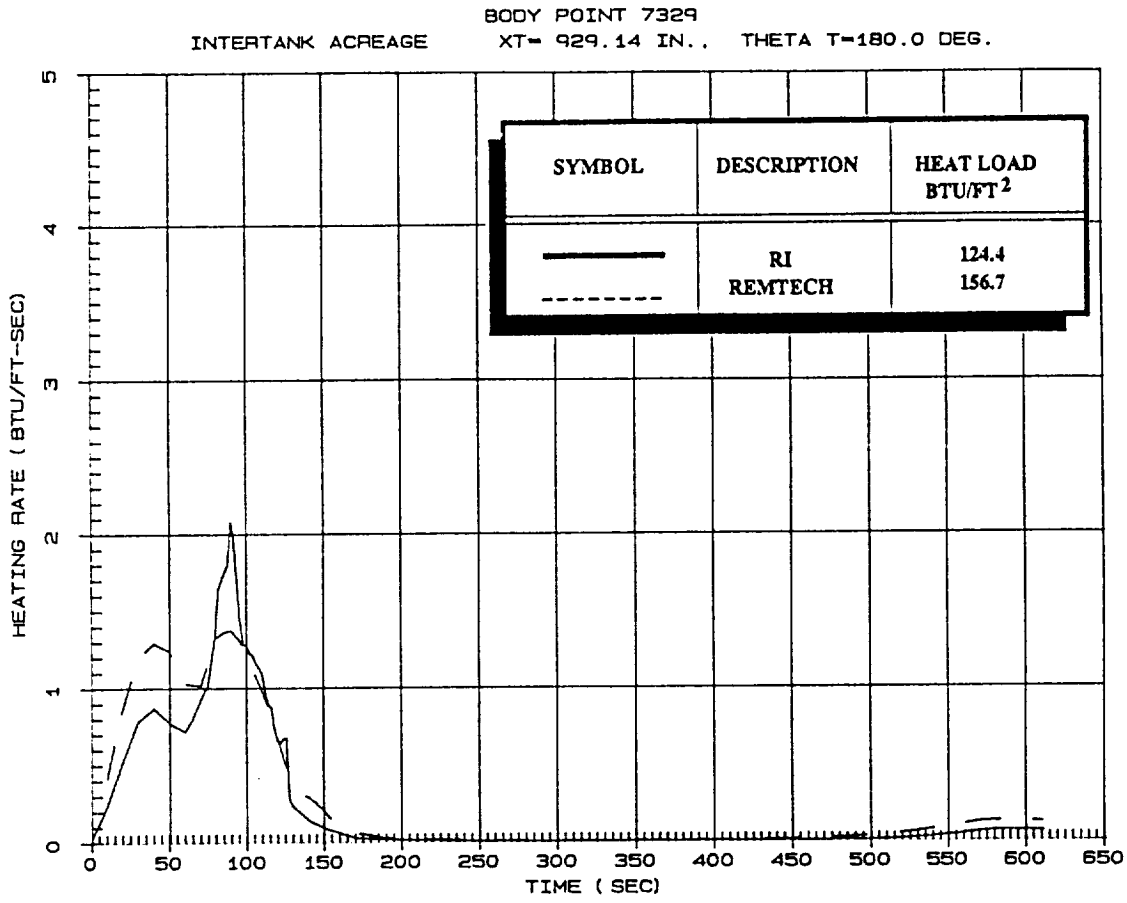

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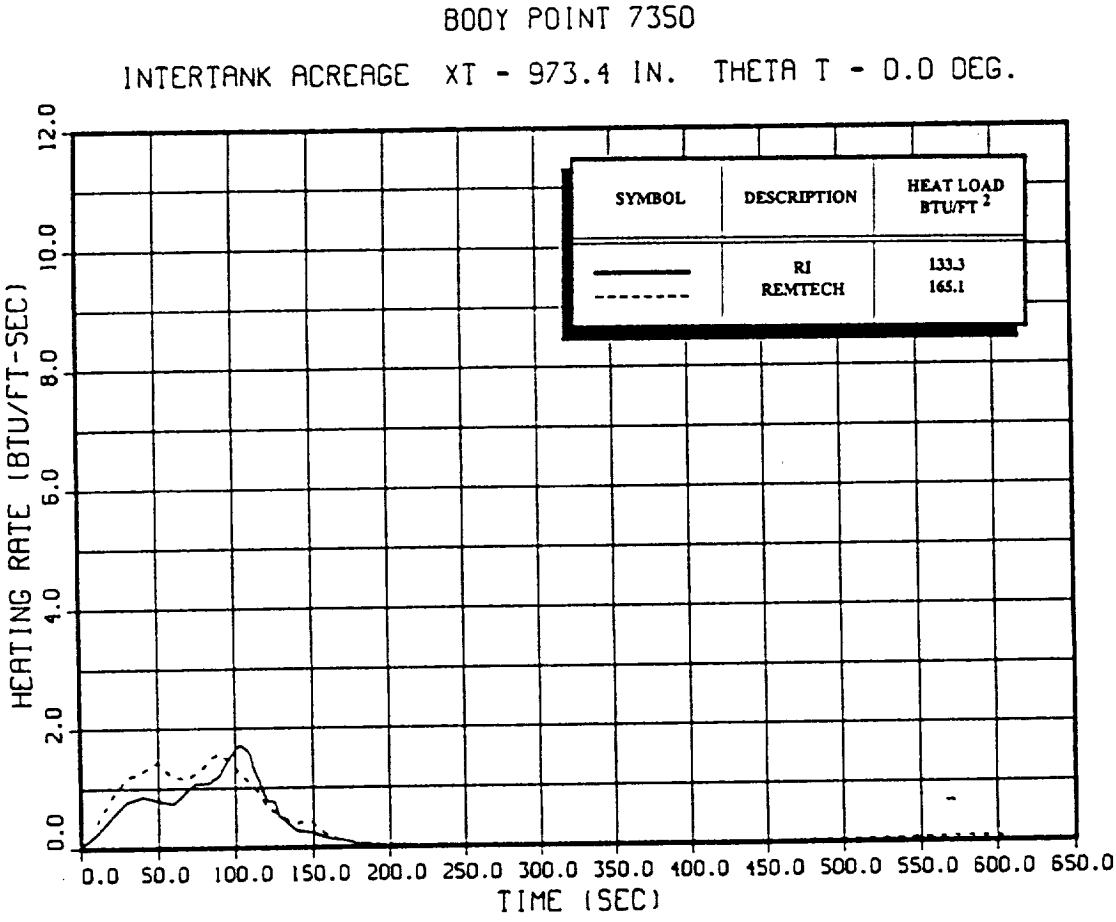

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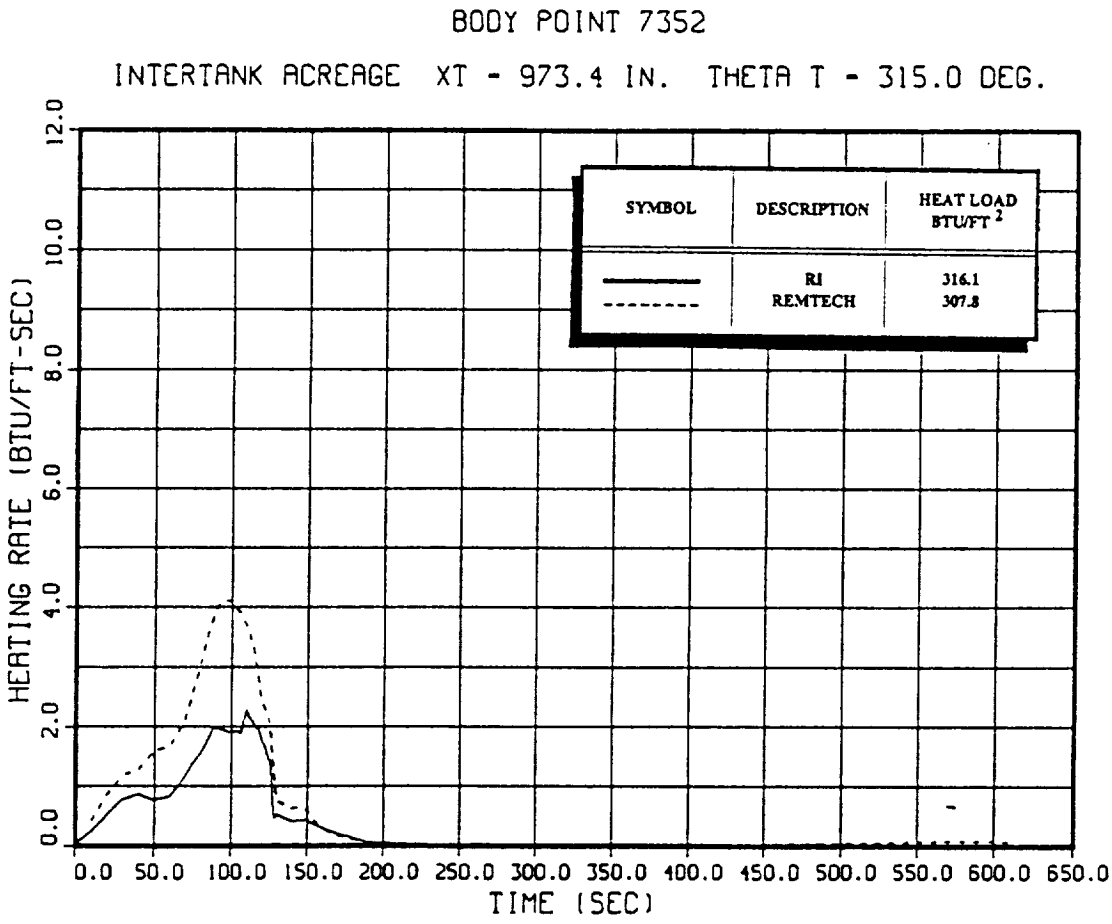

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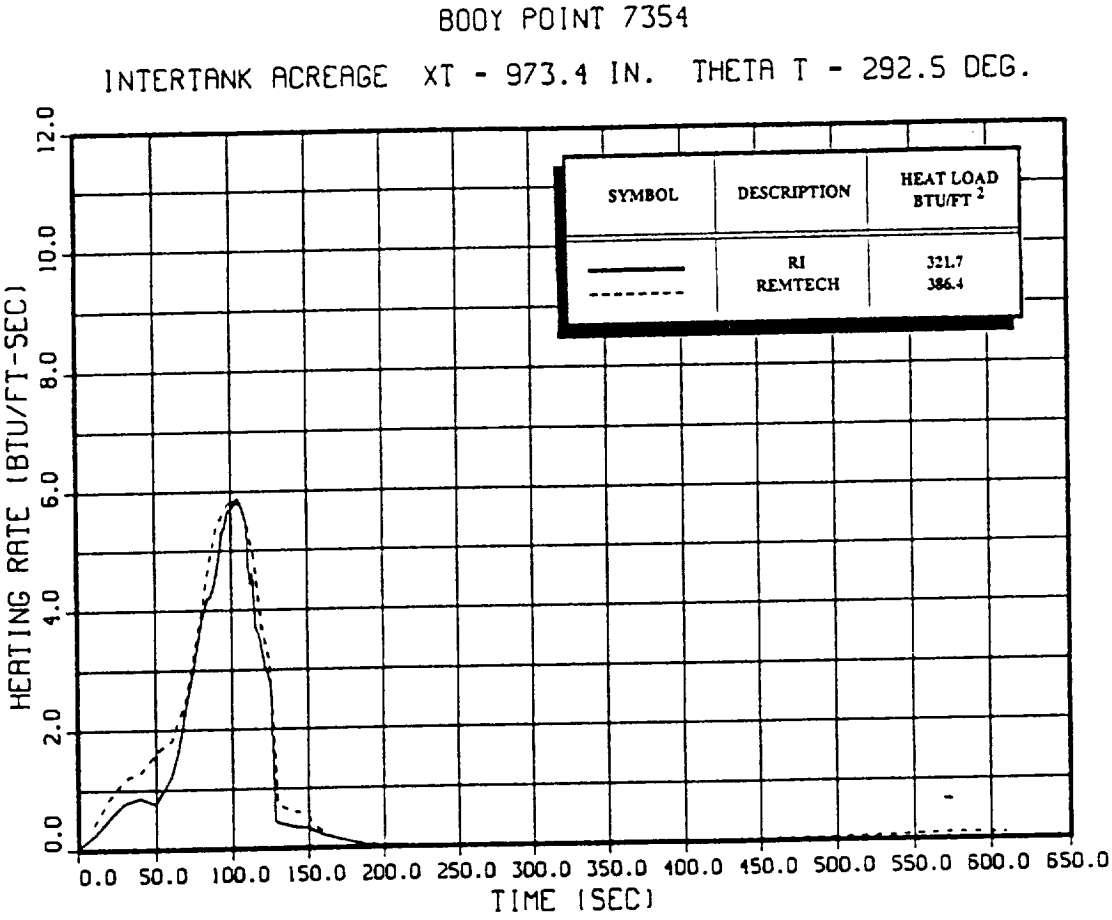

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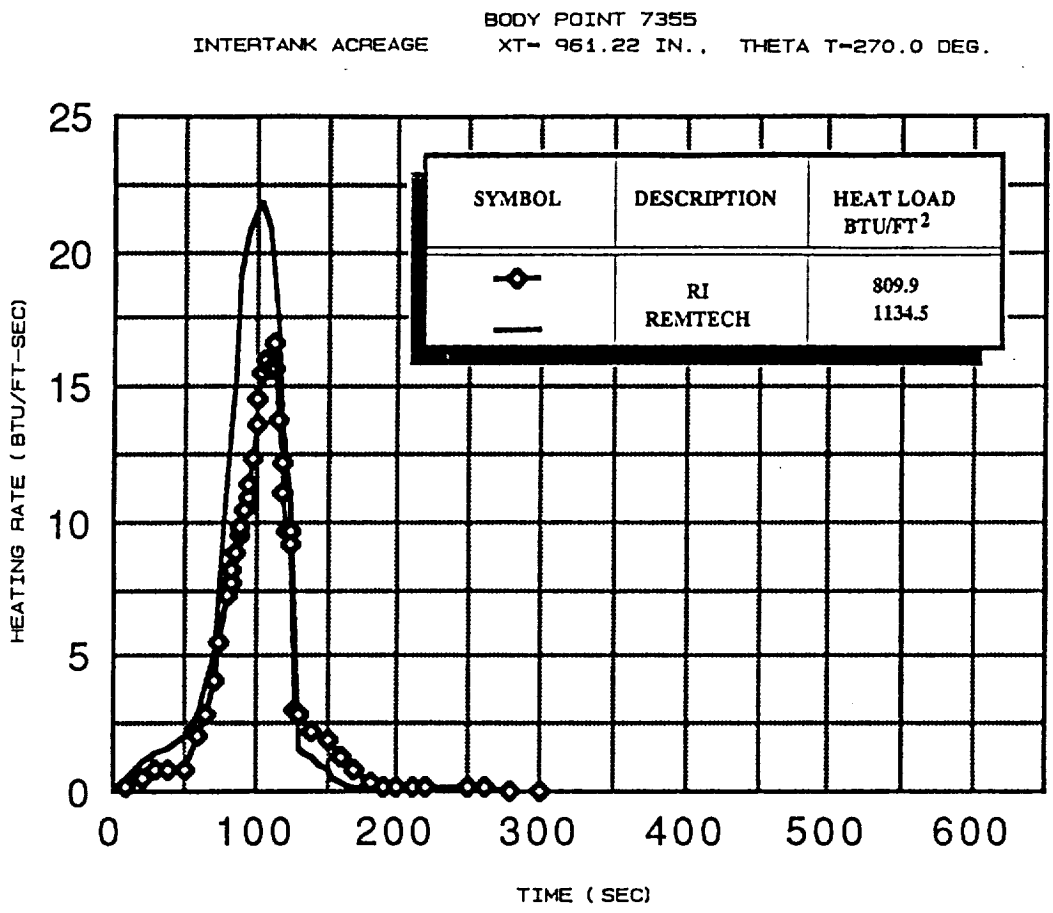
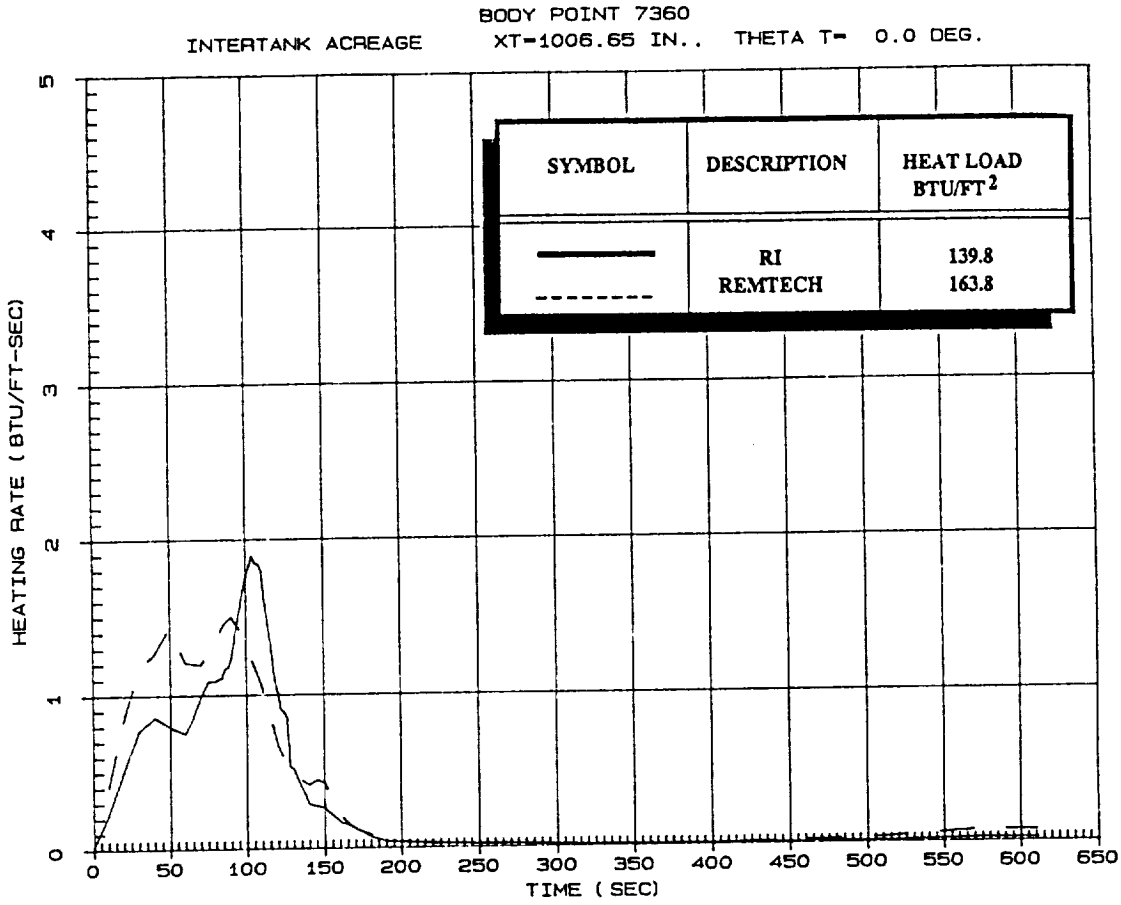
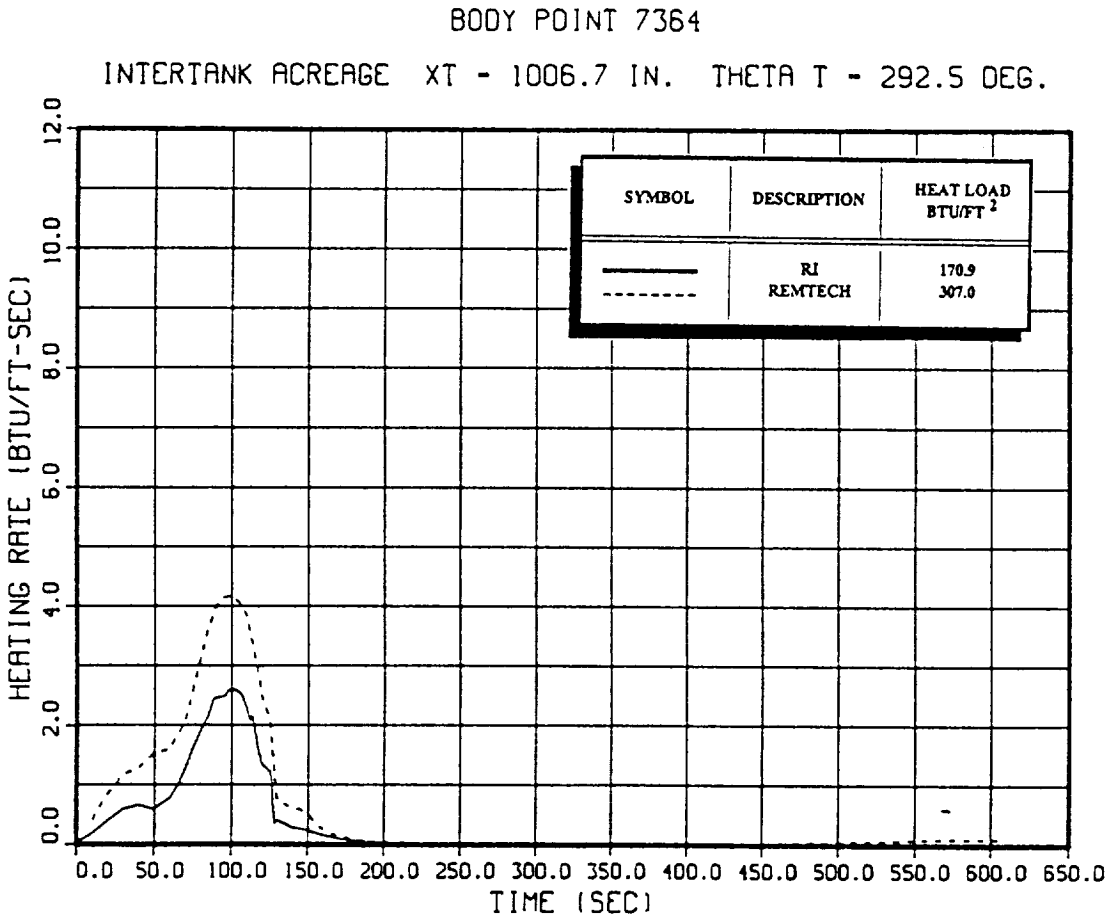


- RI IVBC-3 low. Calculated without stringer factor.
- Potential TPS impact.

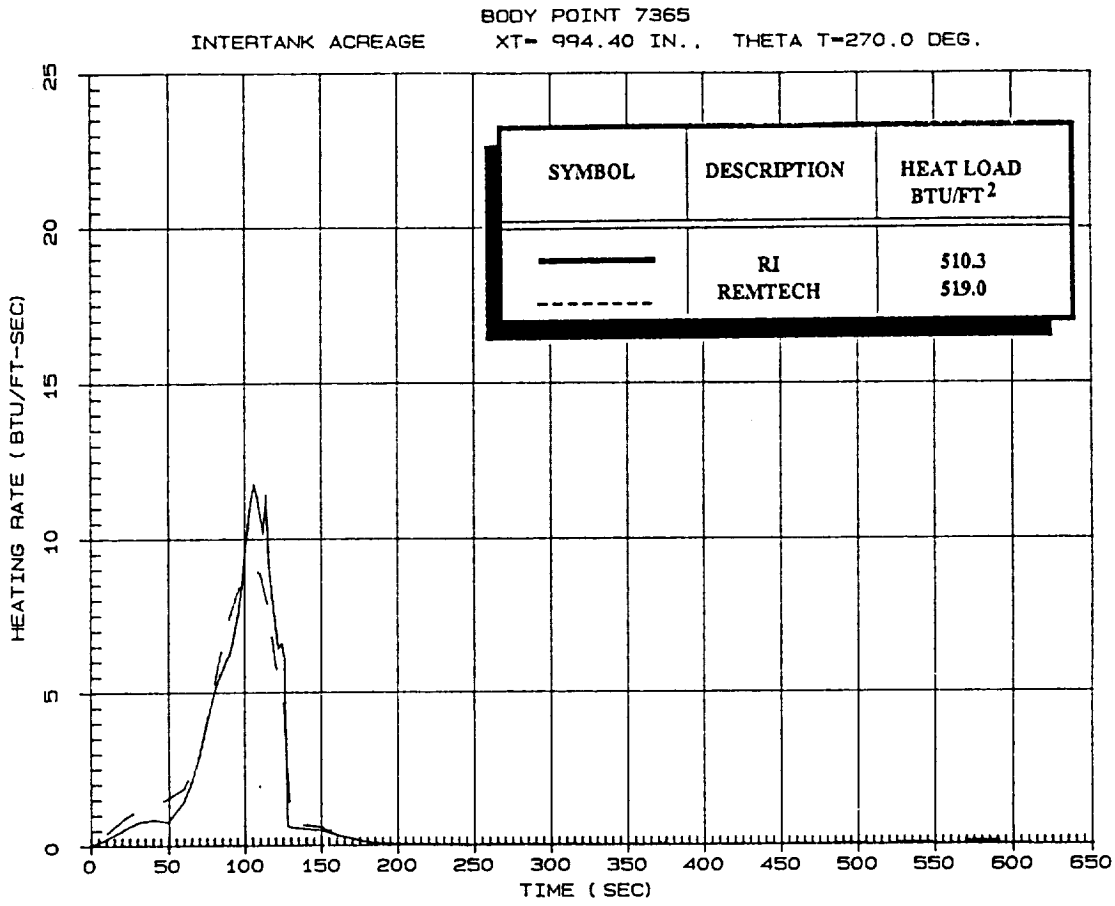


Agreement is acceptable; no TPS impact.

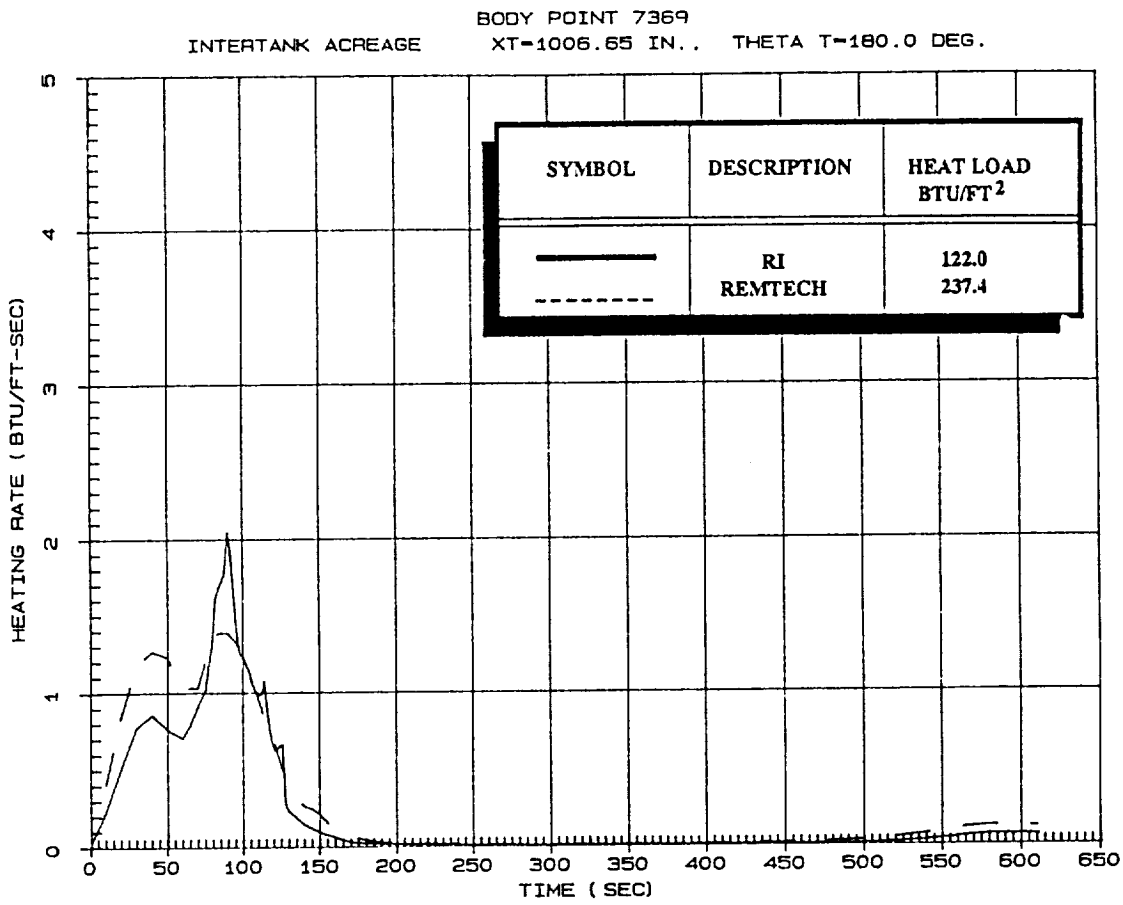


- Difference in heating results in ~0.1 inch of TPS, i.e., within application tolerance.

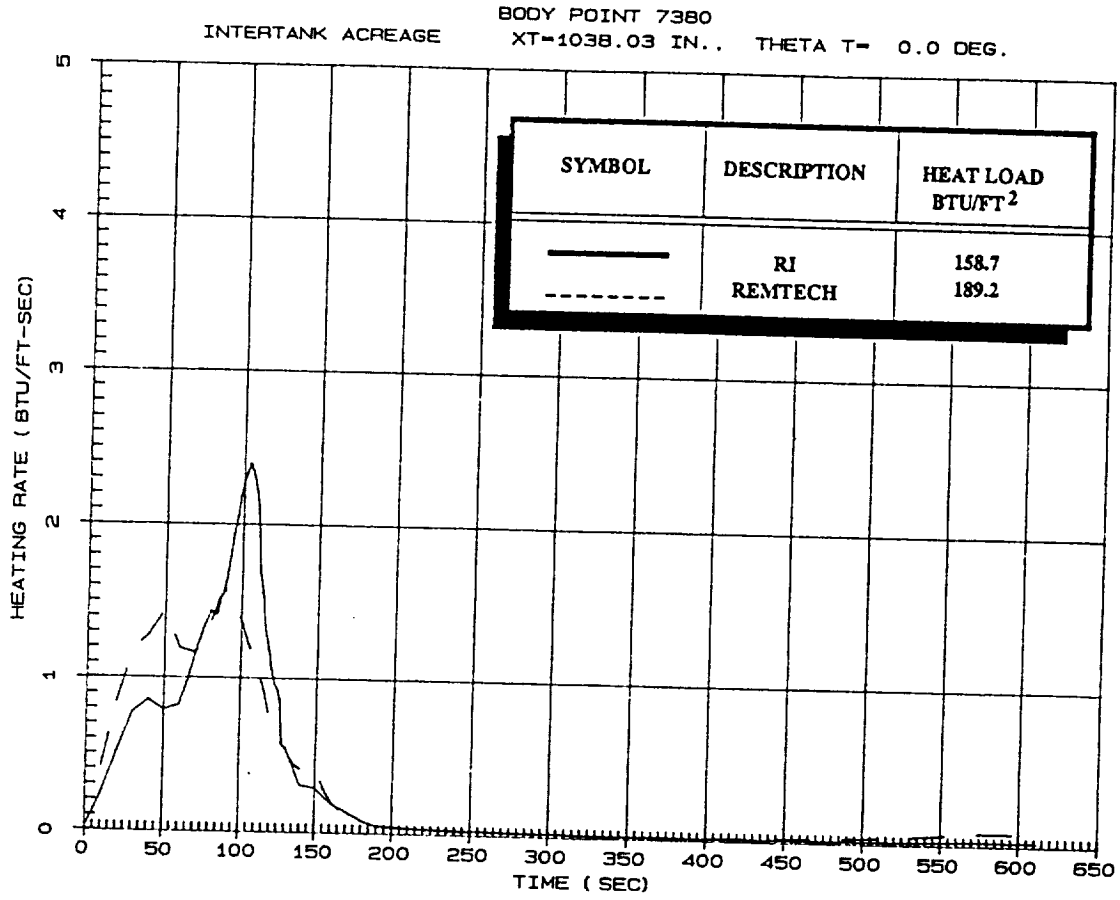
Agreement is acceptable; no TPS impact.



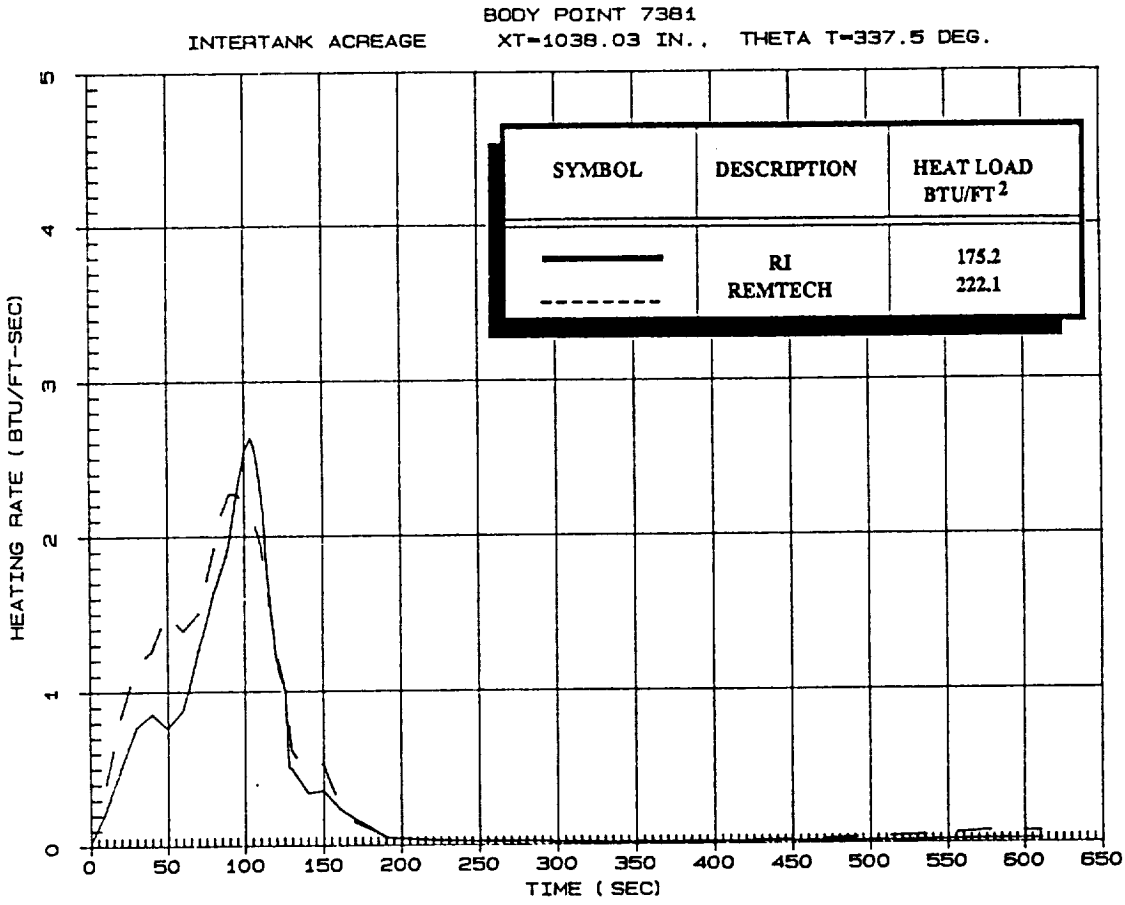
Agreement is acceptable; no TPS impact.



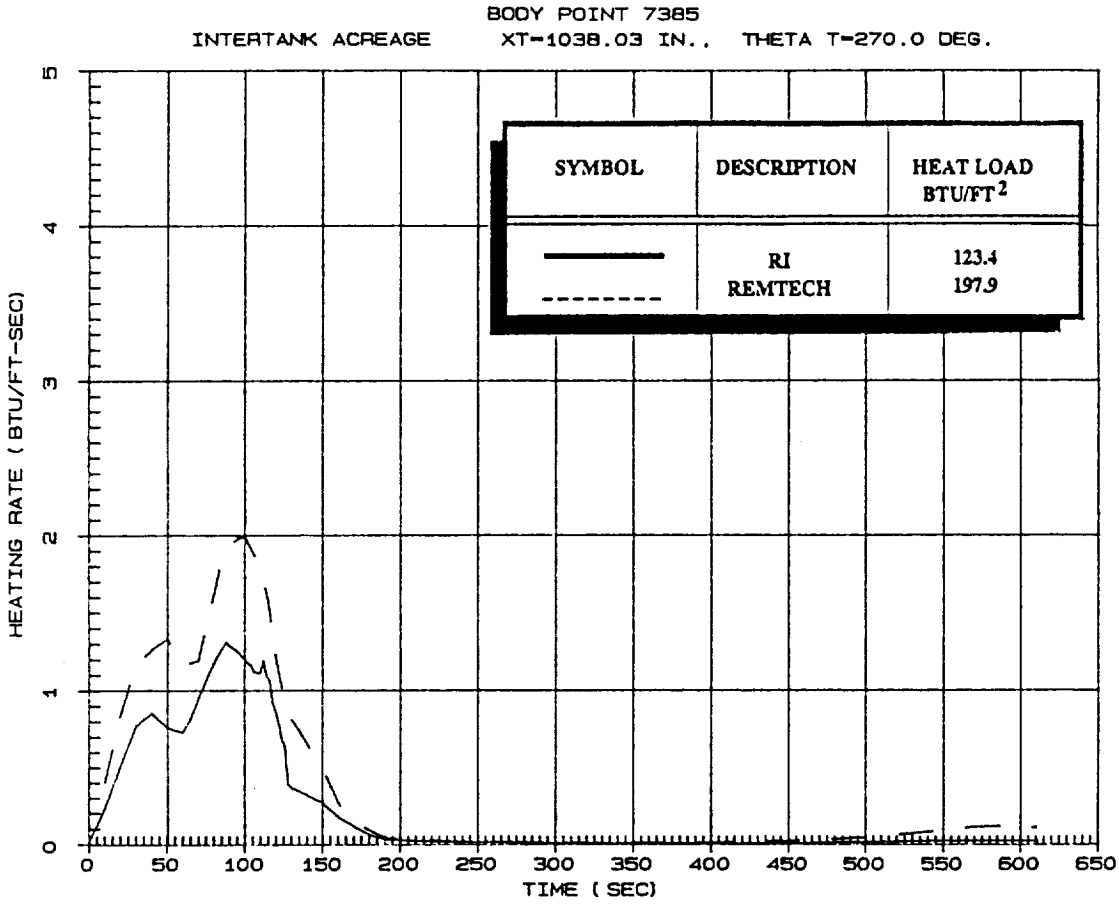
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.

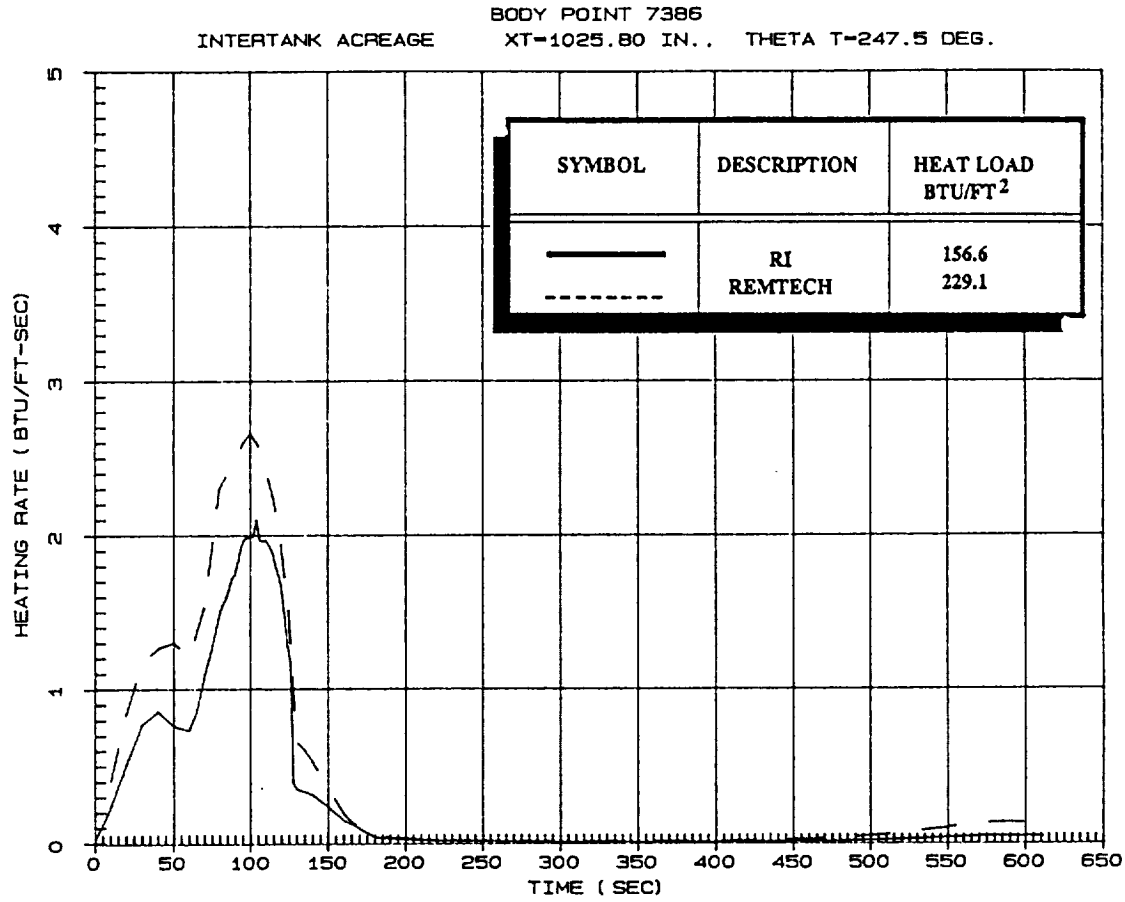


Agreement is acceptable; no TPS impact.

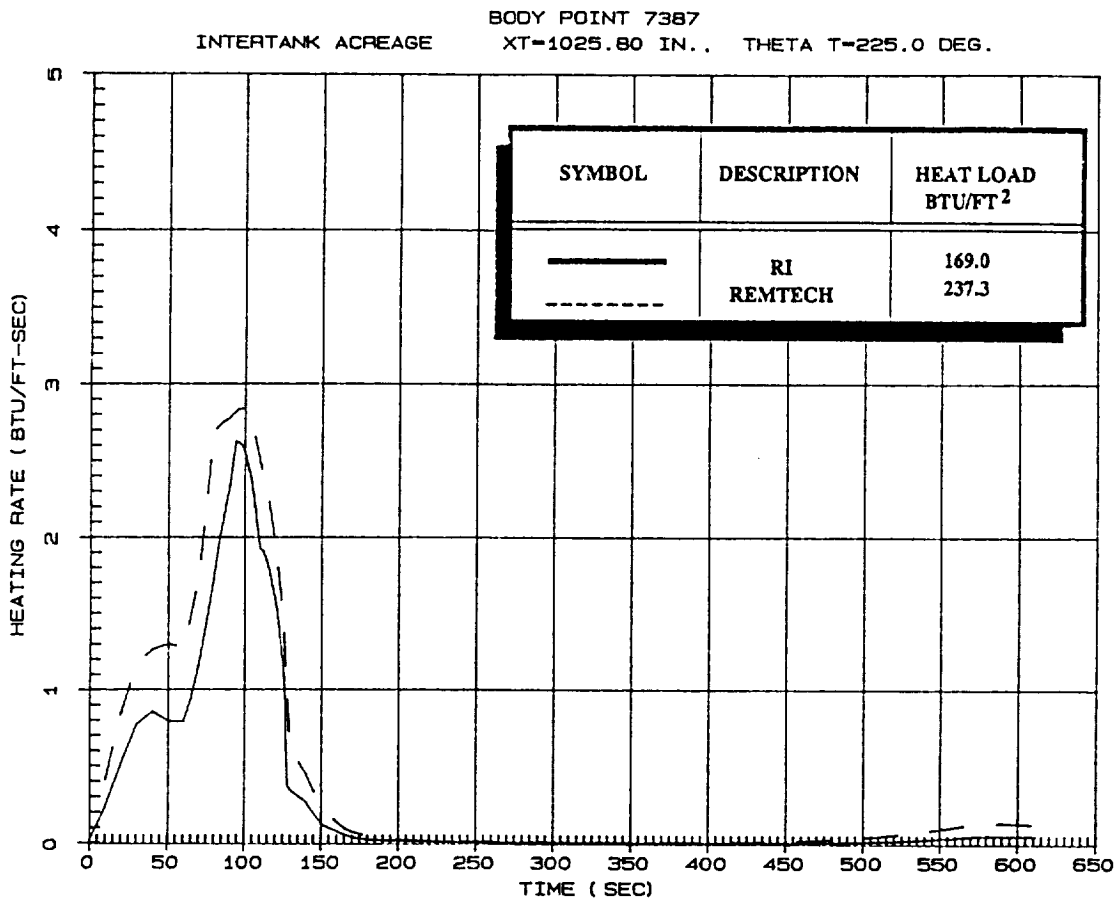


- Difference in heating results in < 0.1 inch of TPS.

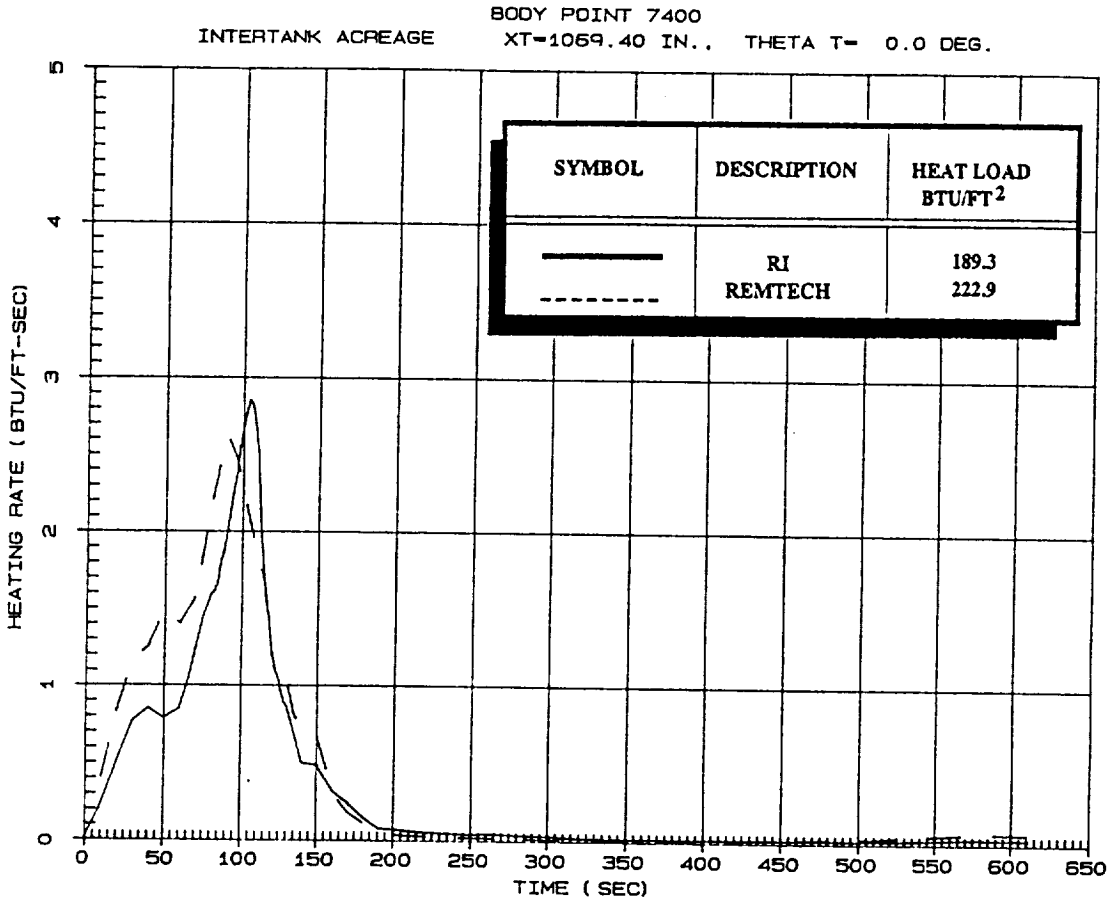
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



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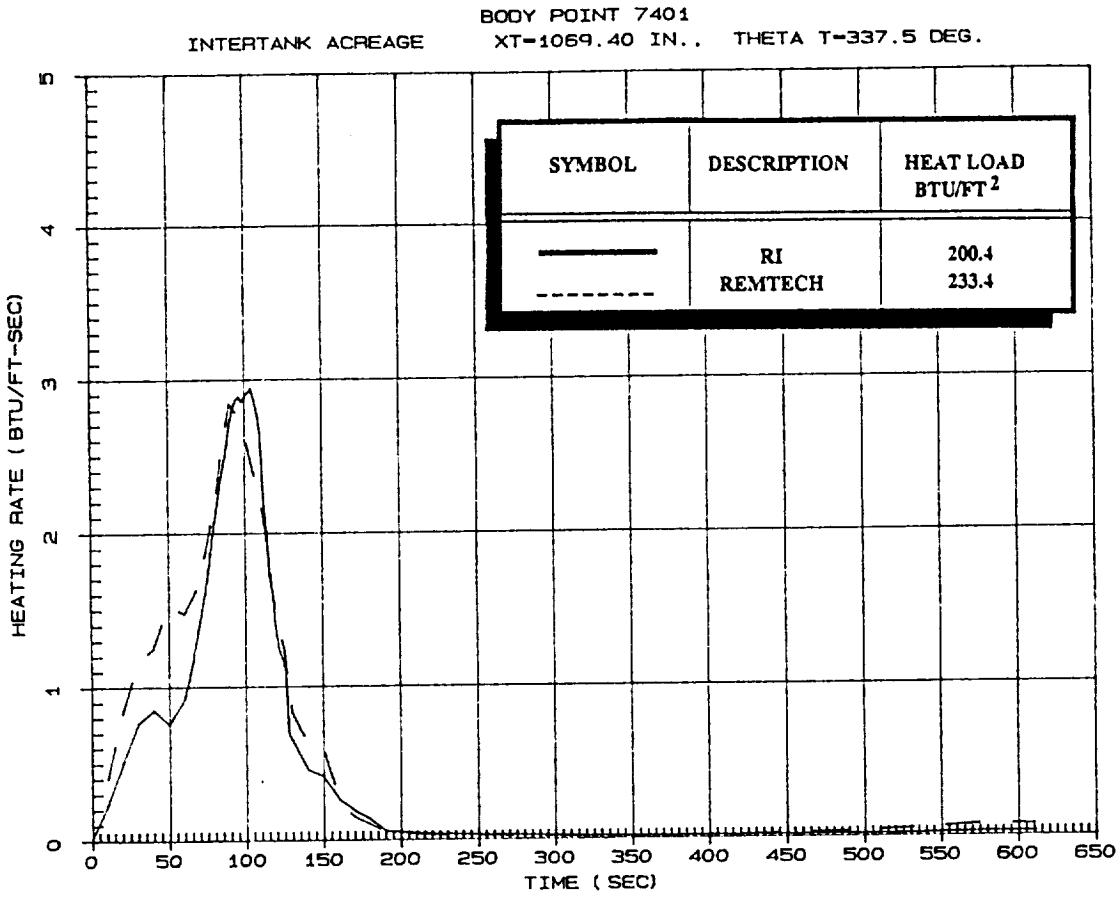

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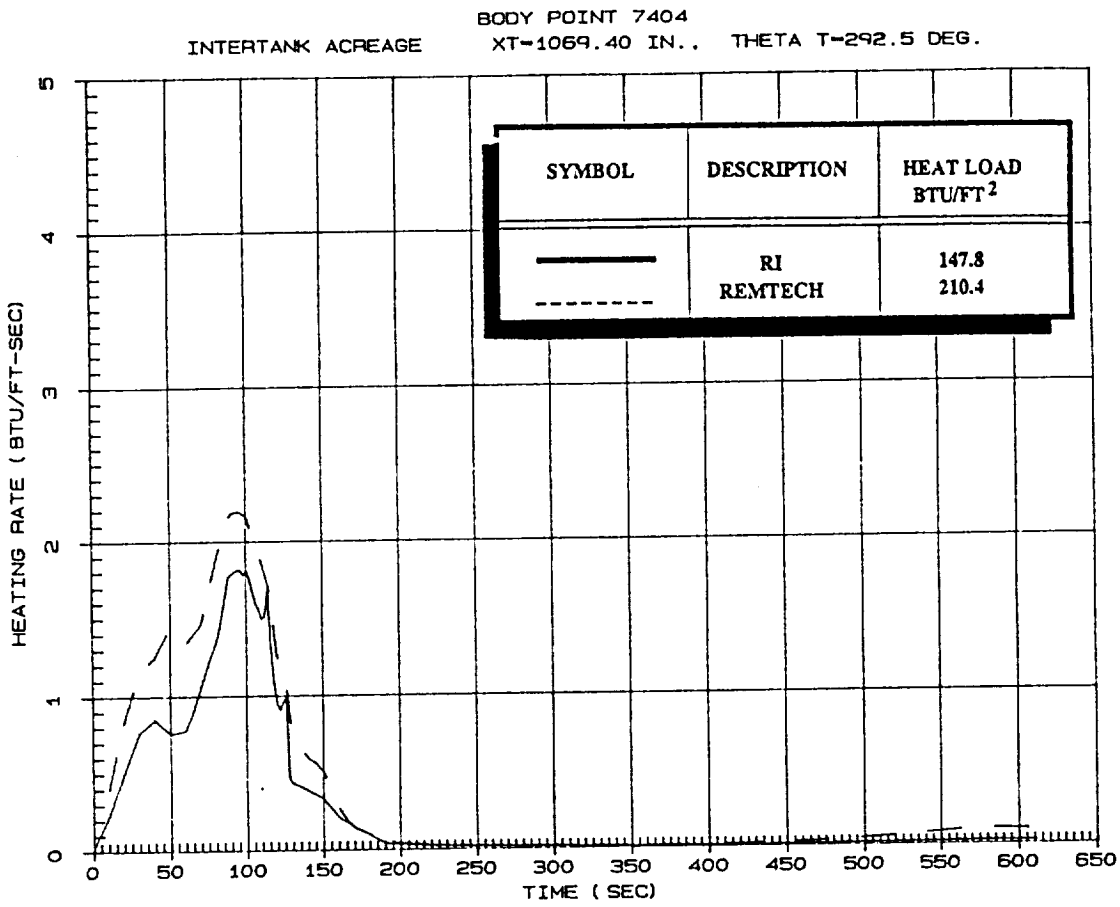

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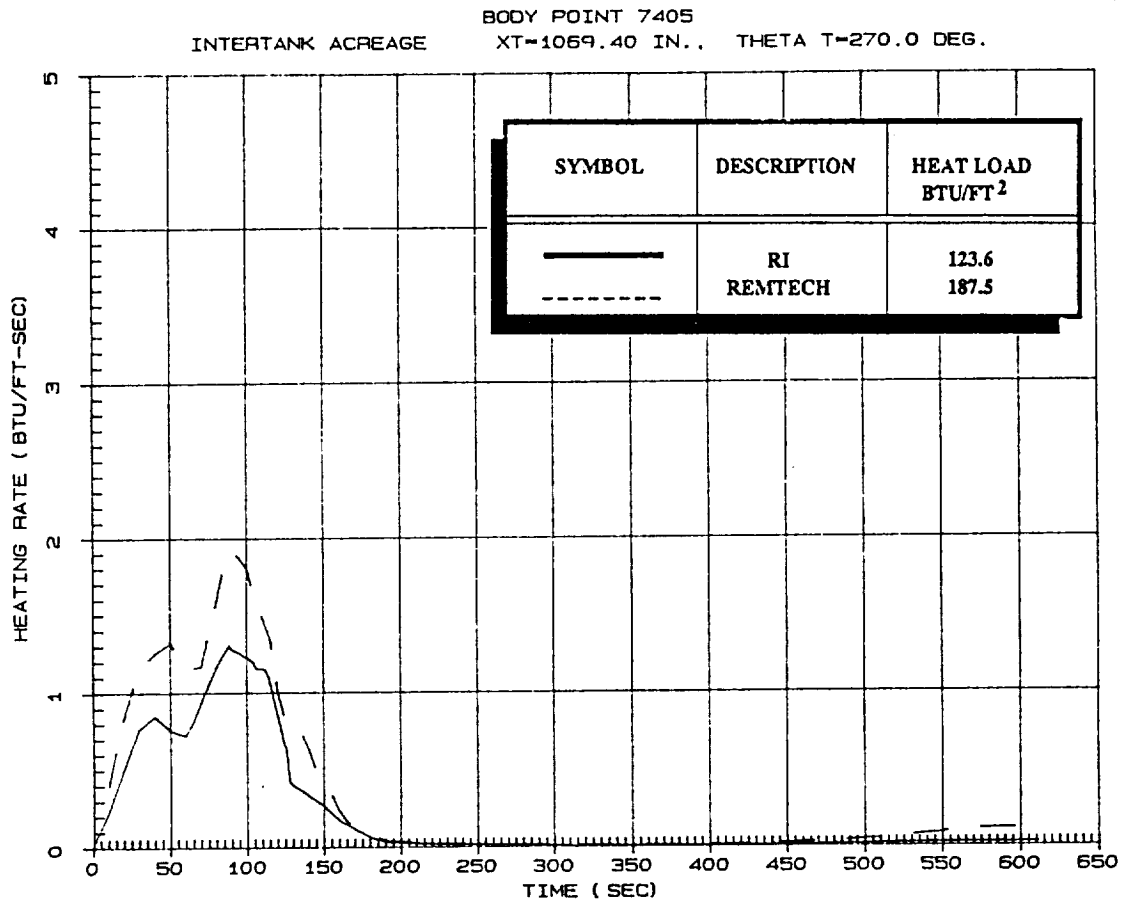

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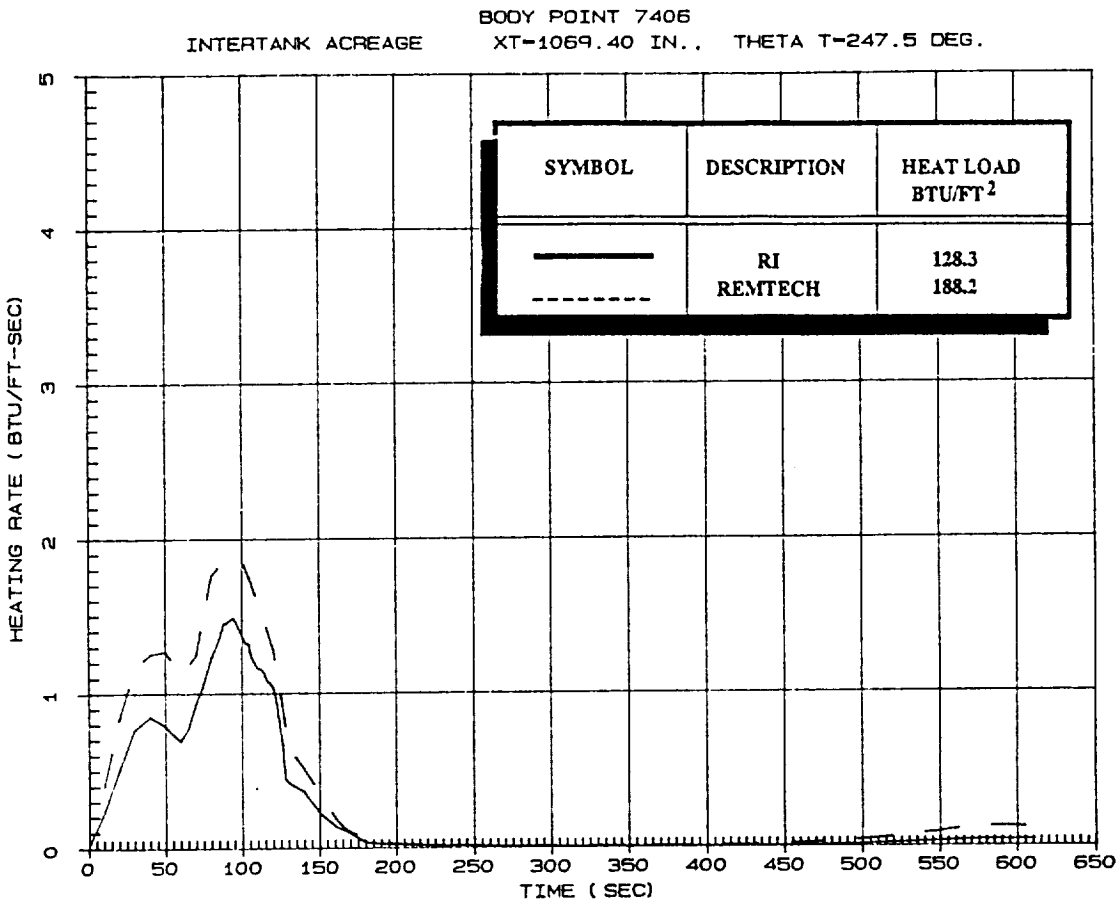

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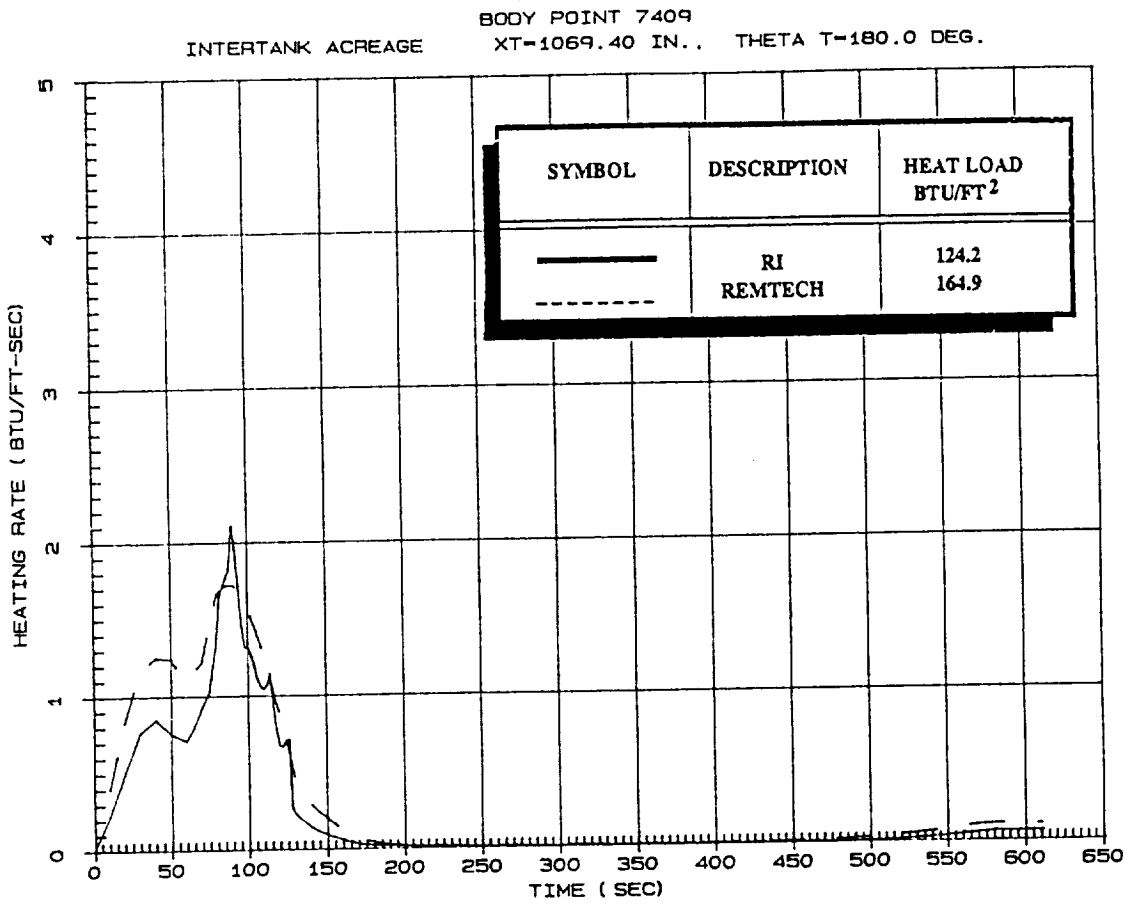
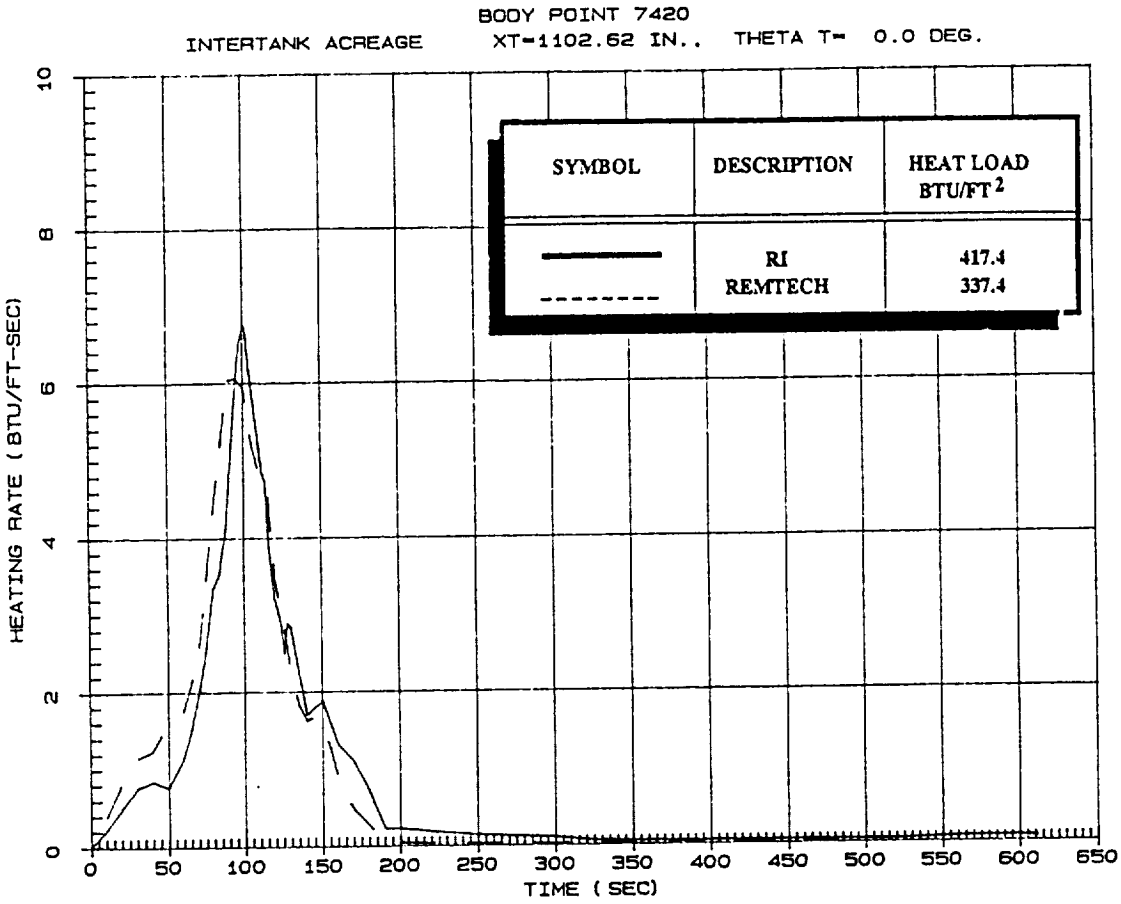
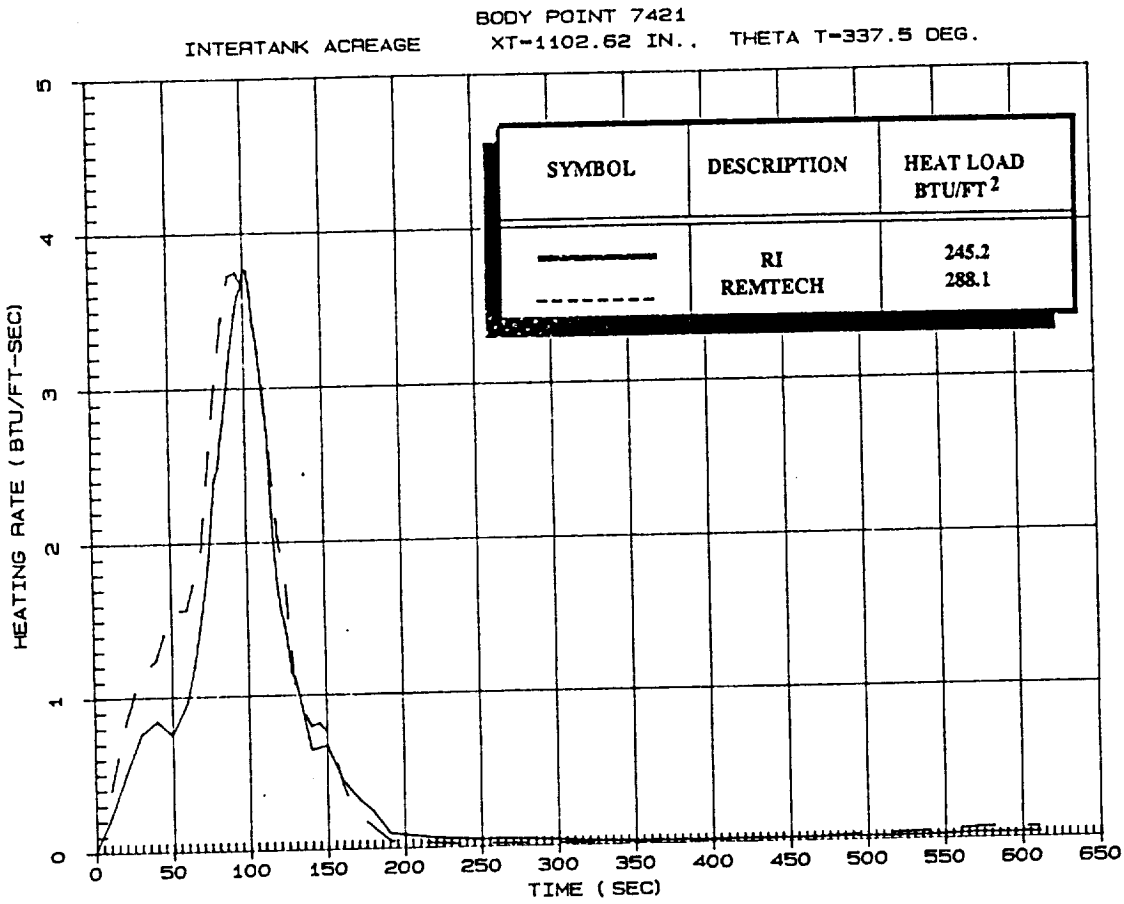


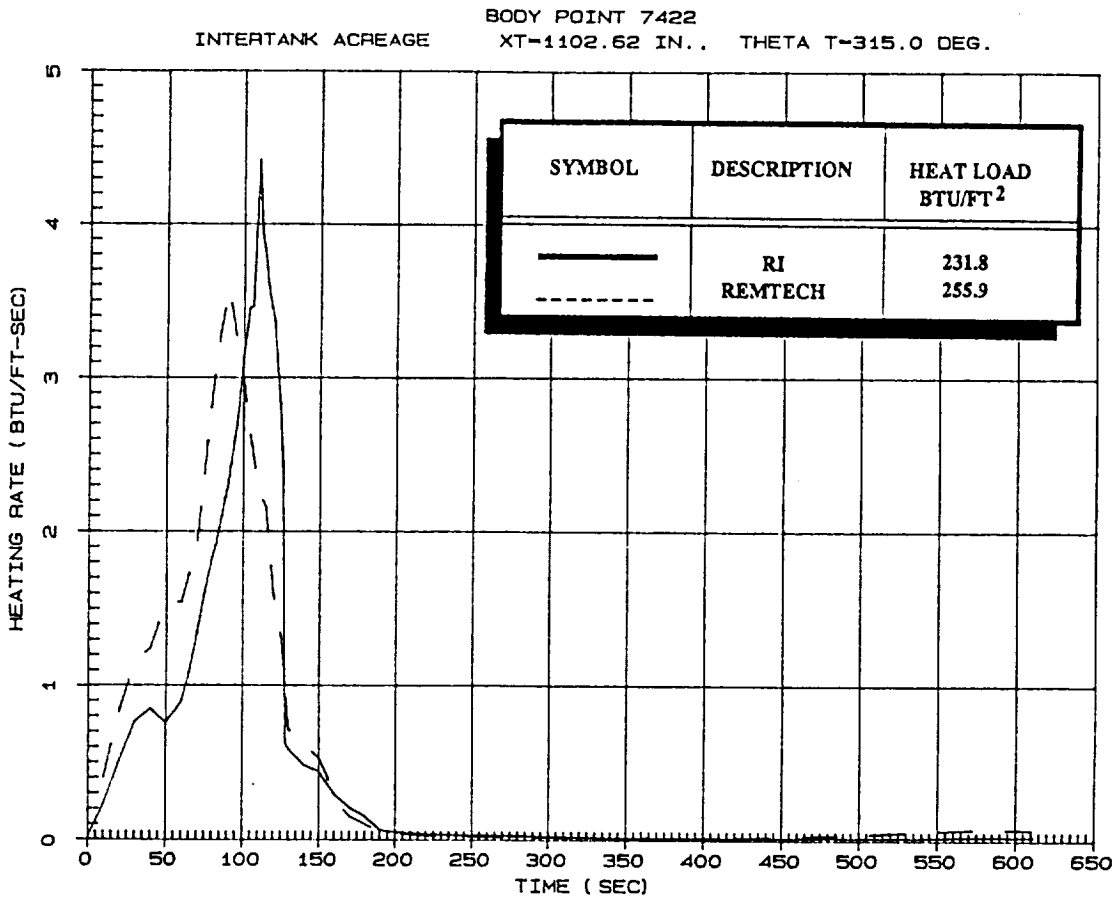
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



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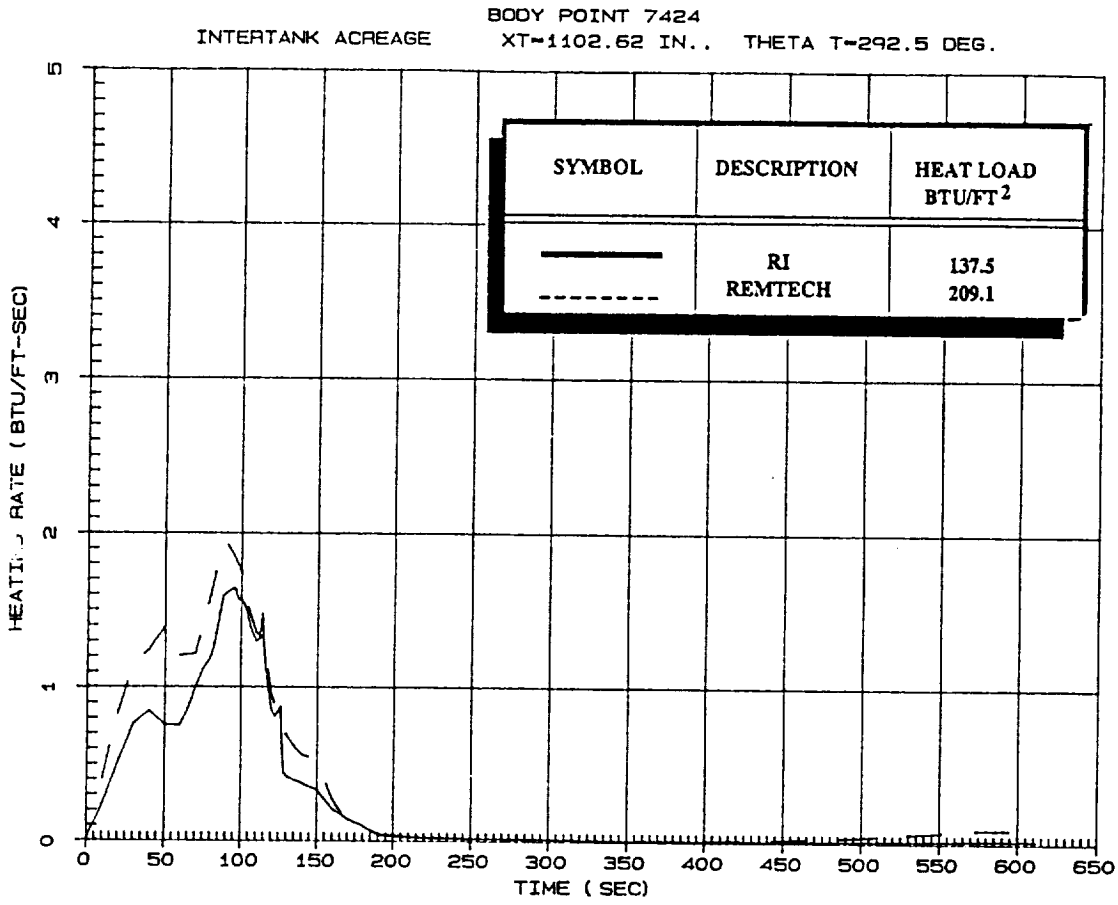

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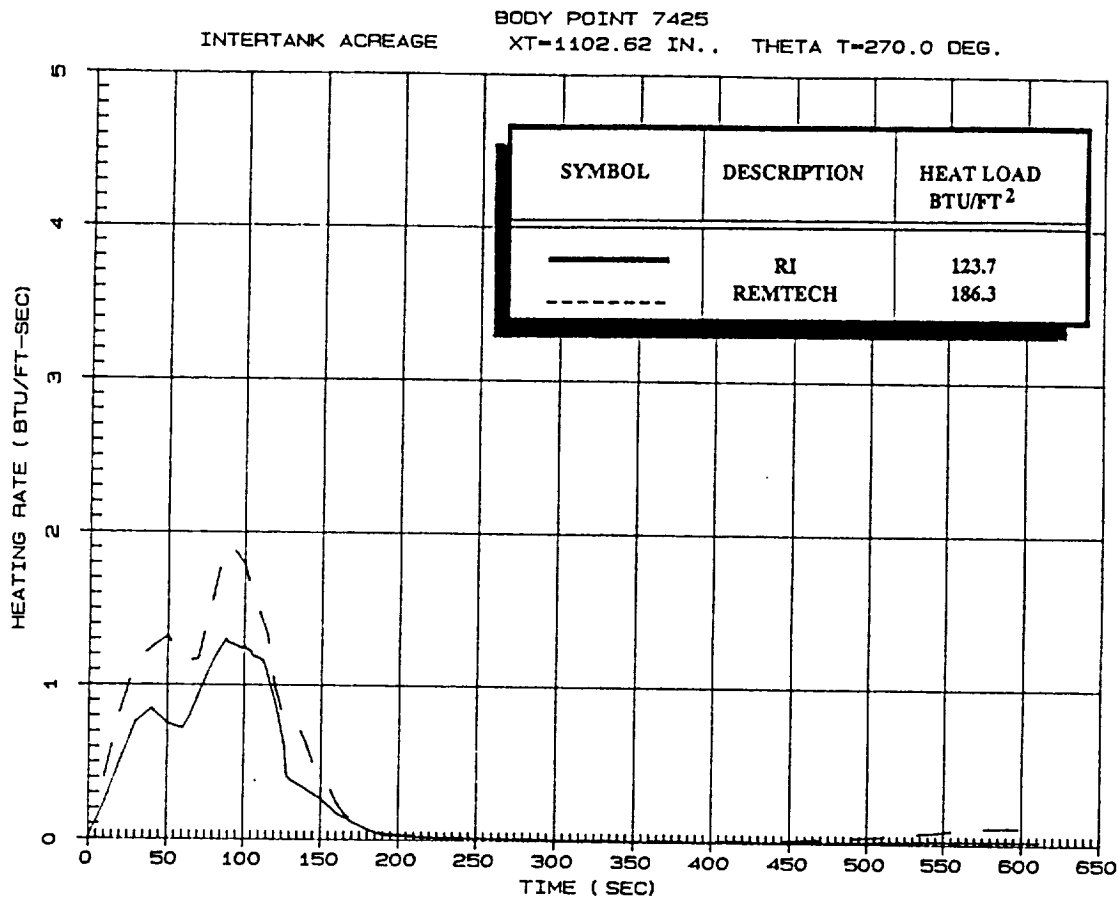

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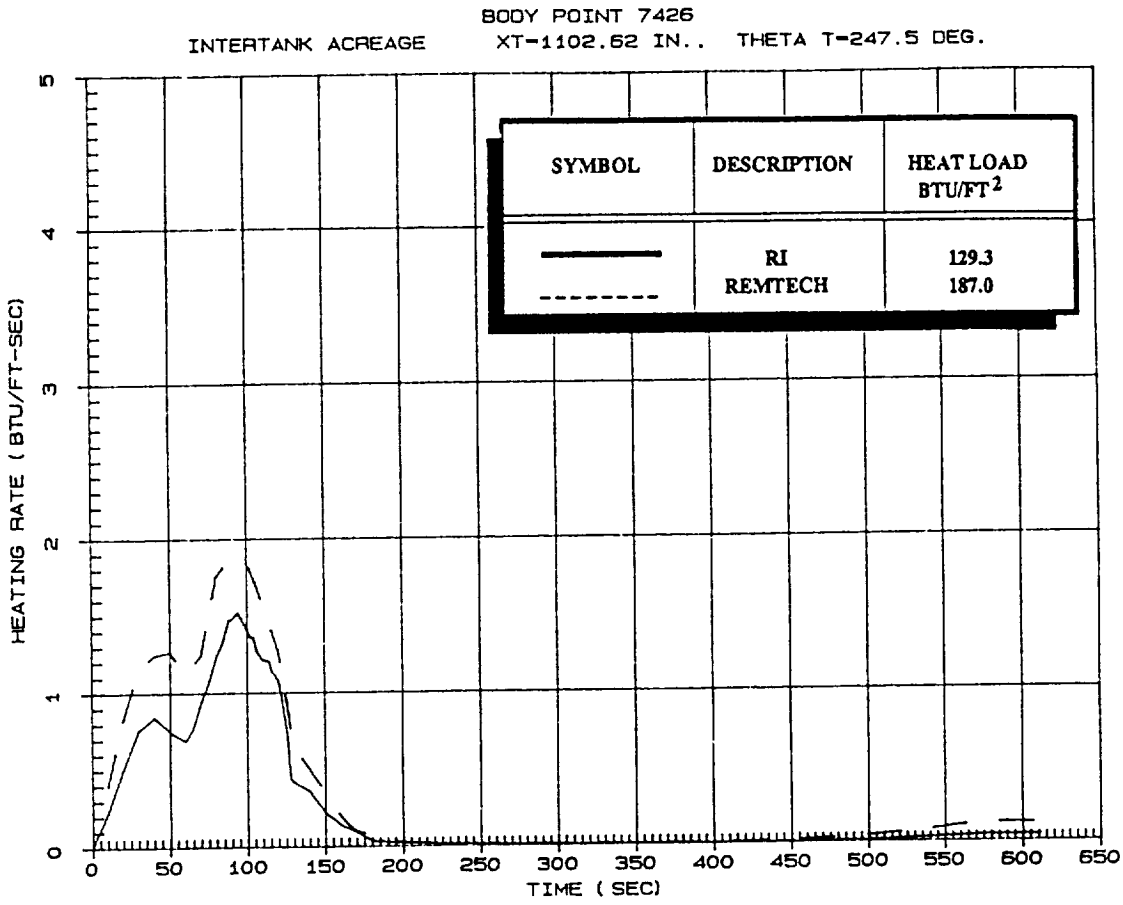

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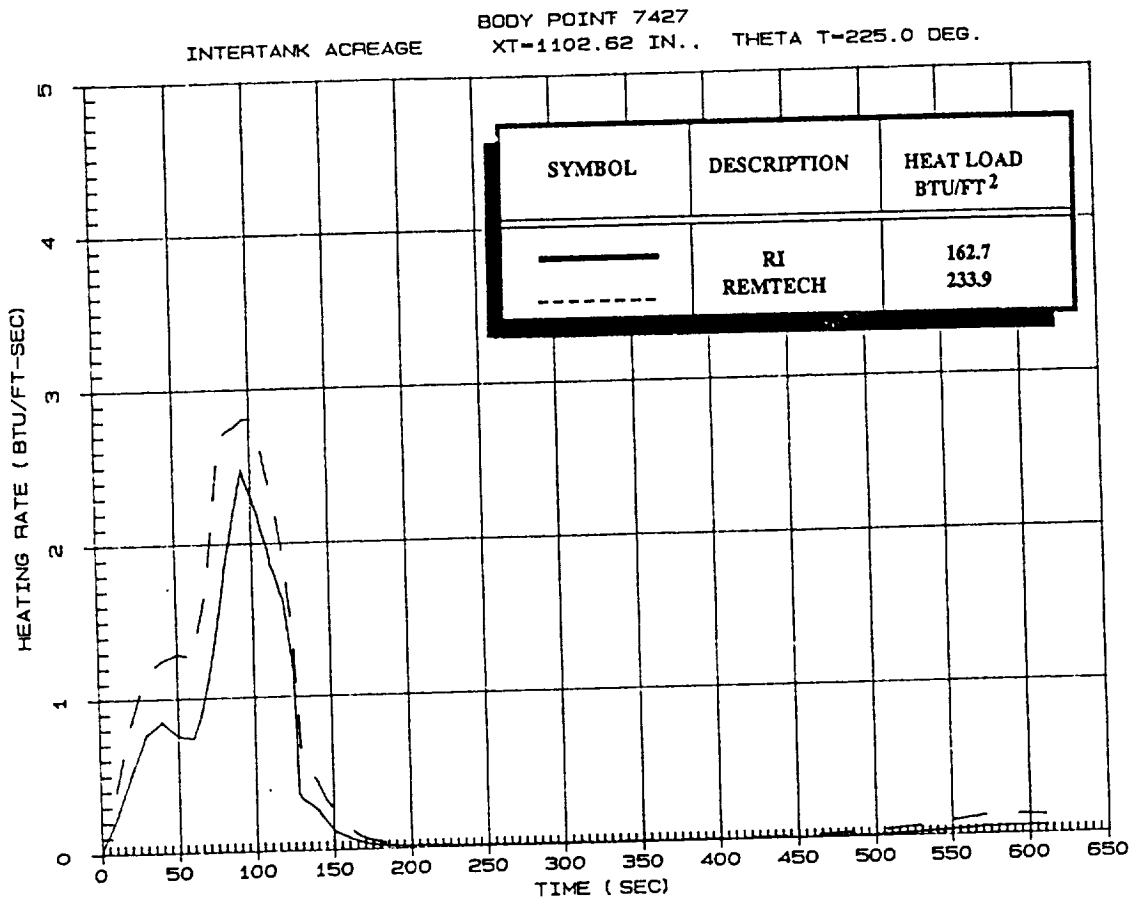

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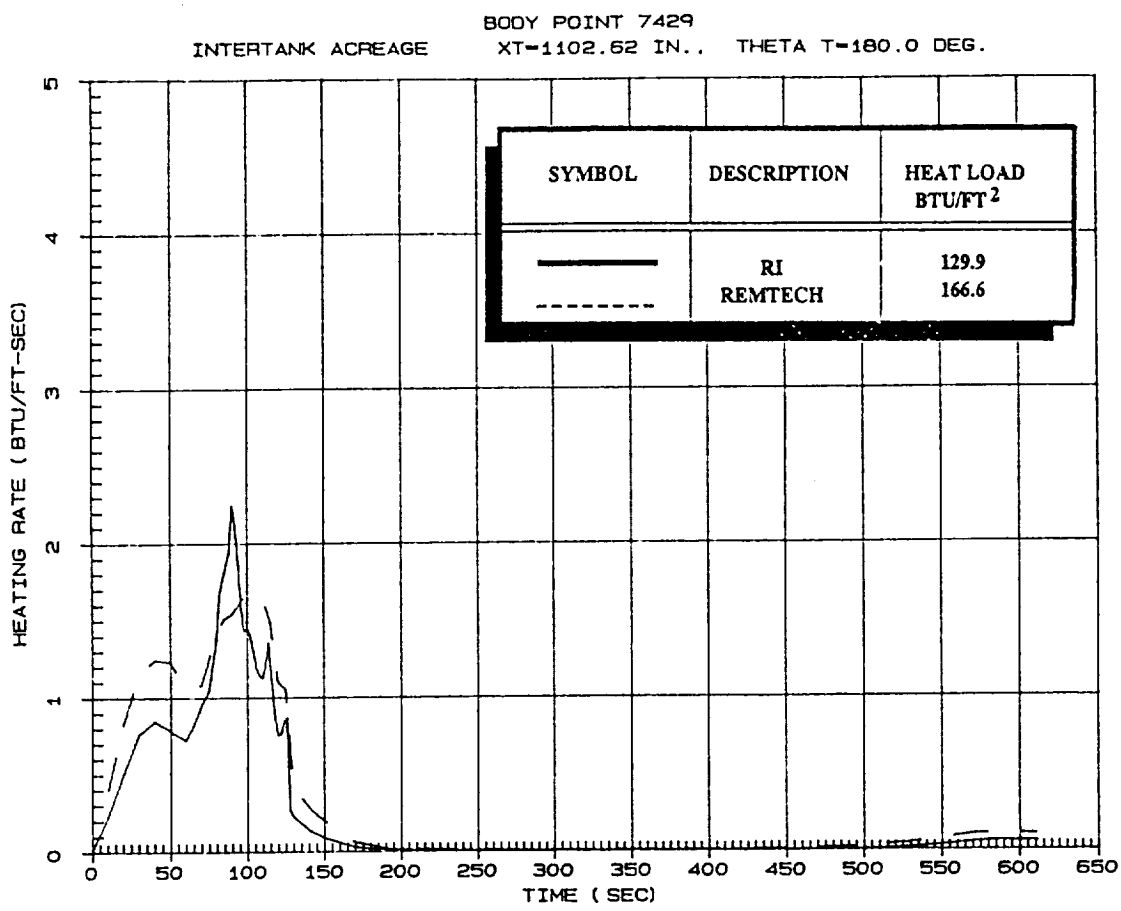

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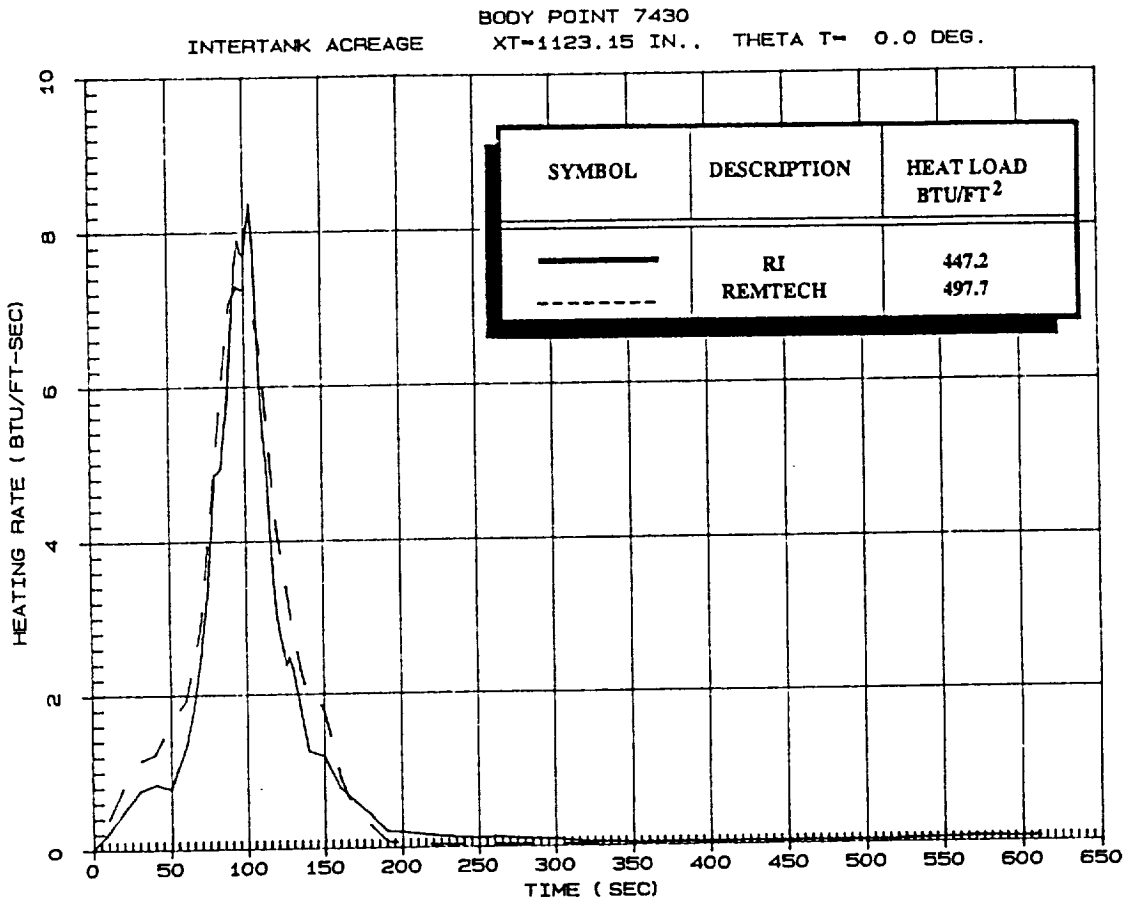

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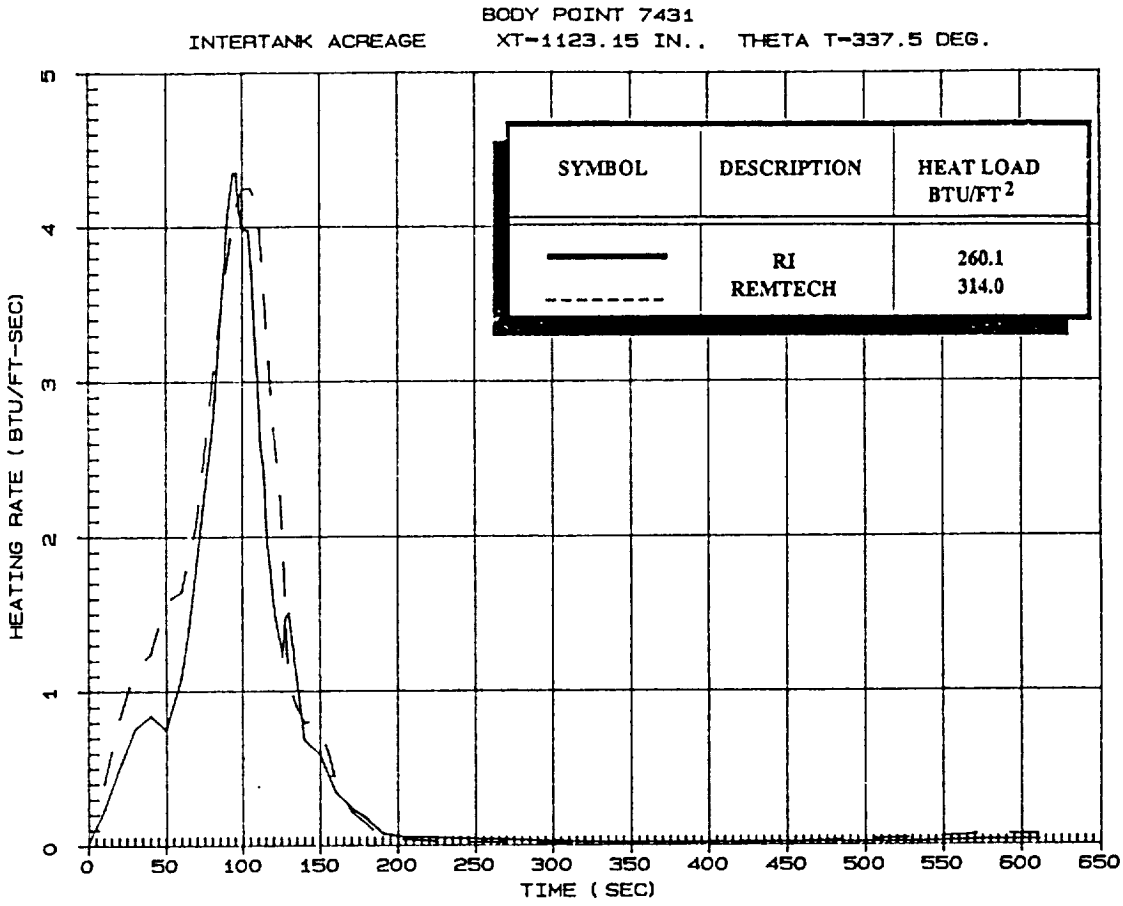
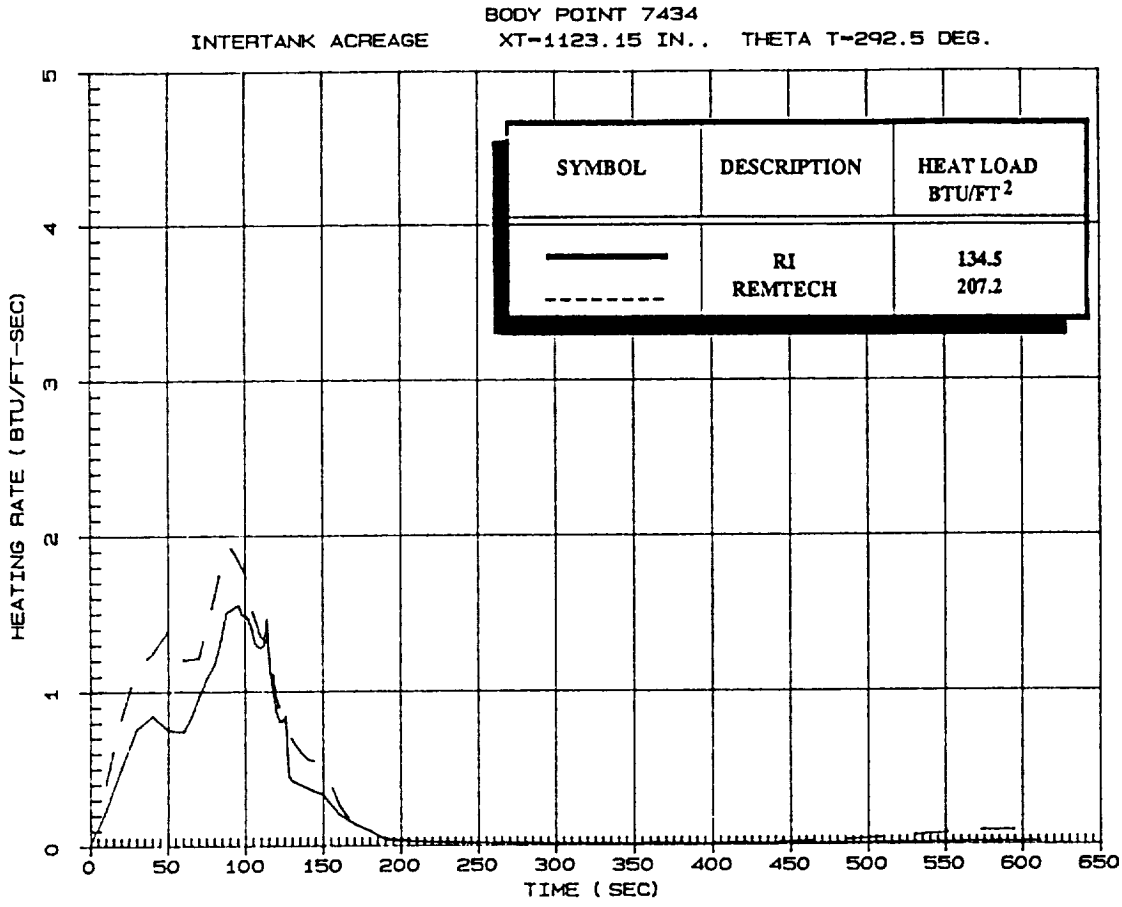
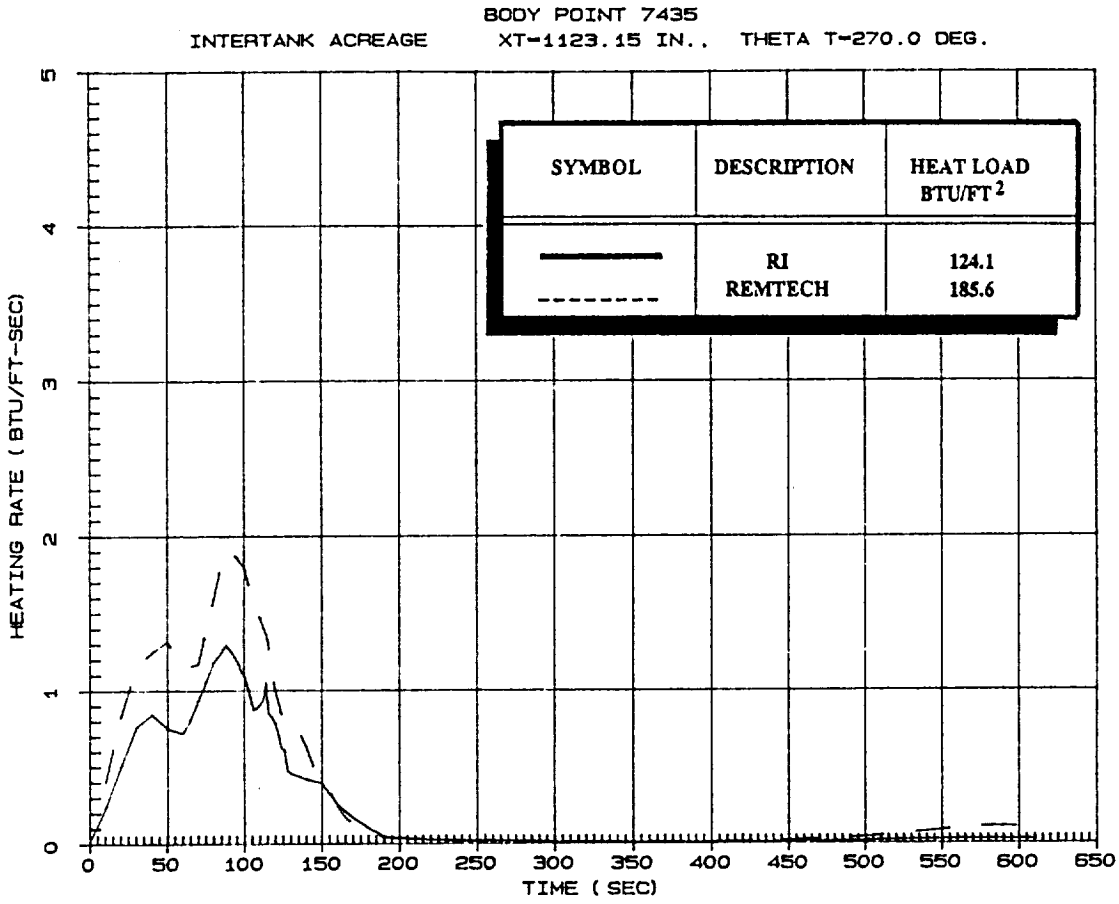


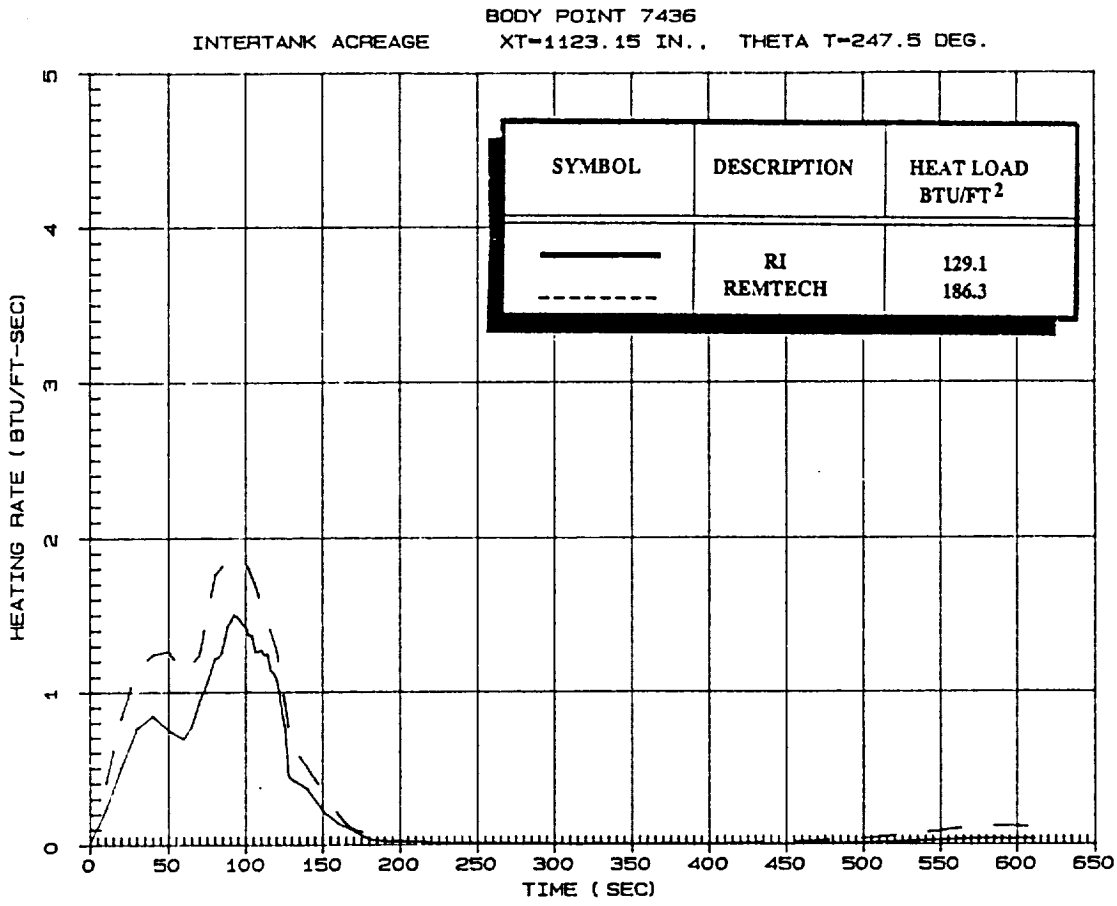
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



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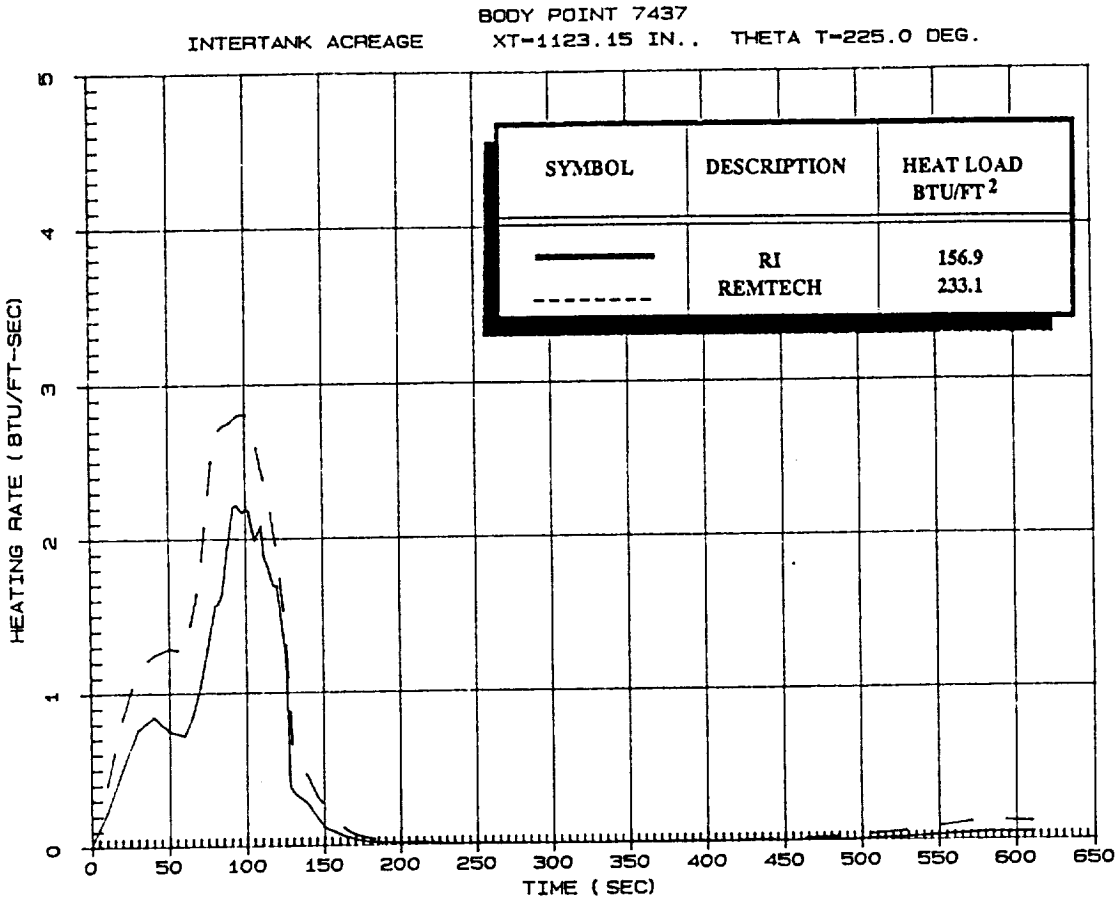

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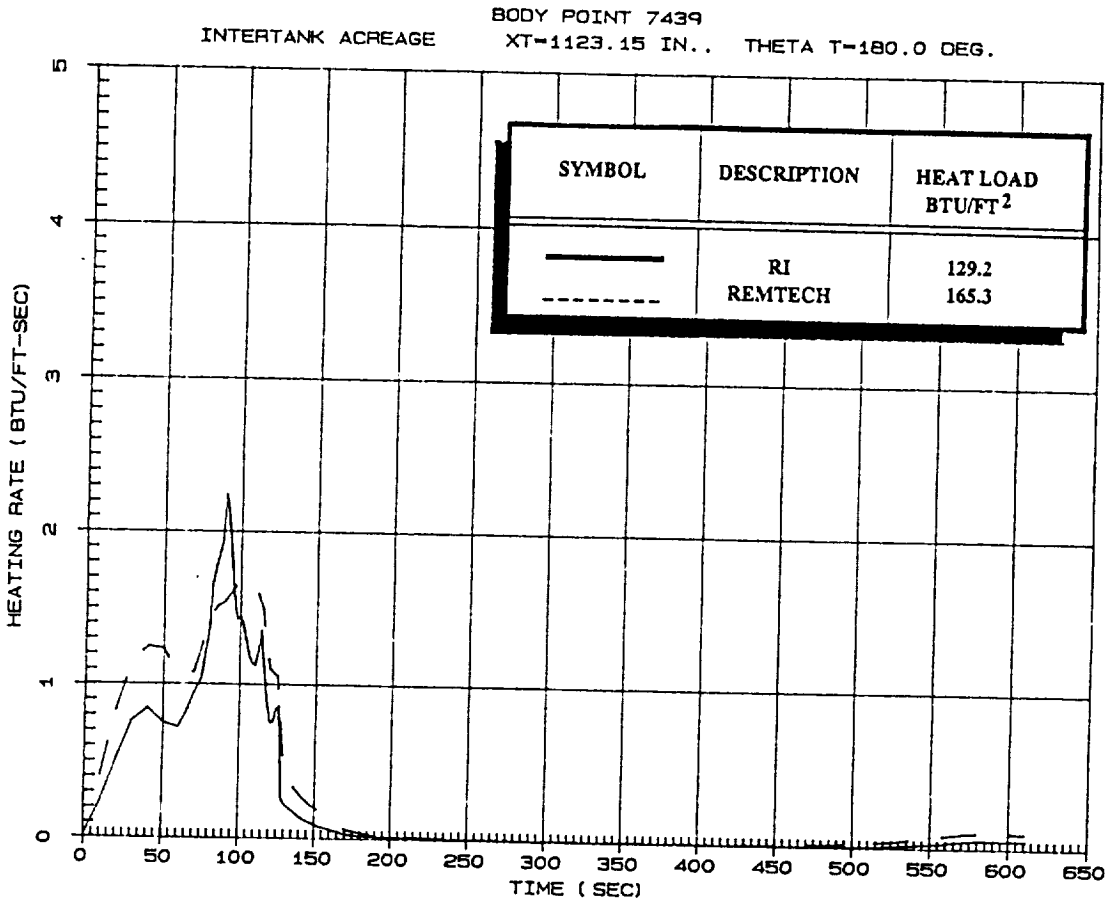
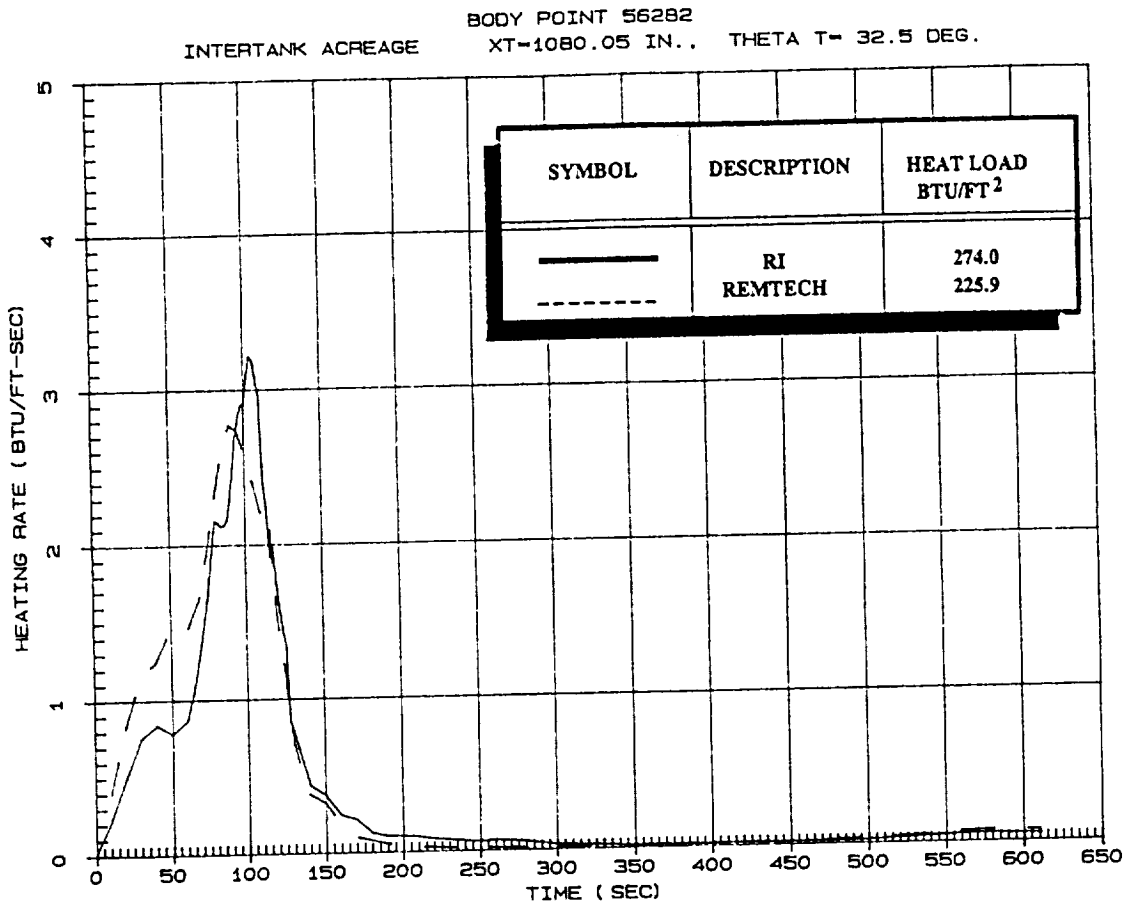
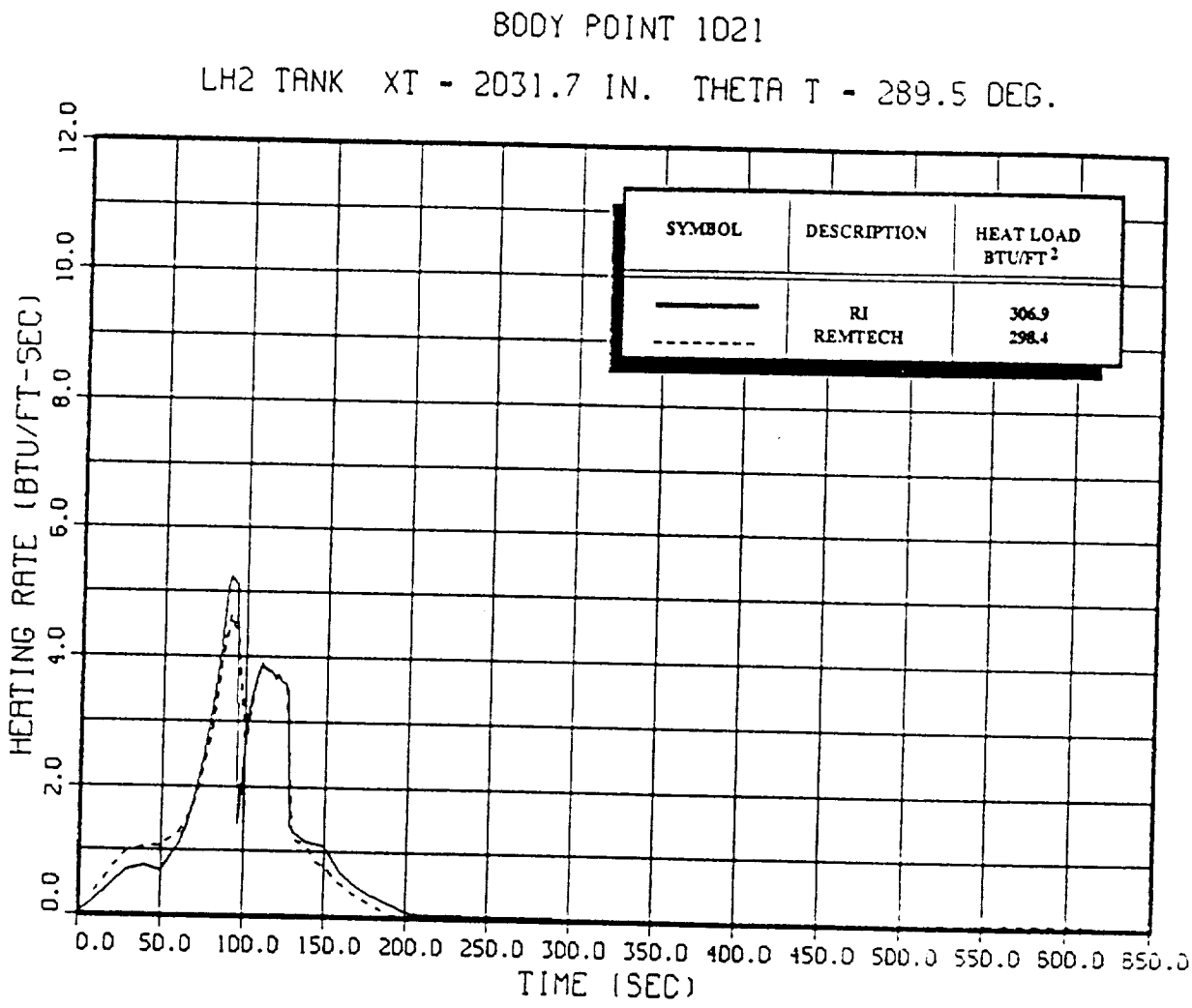


Agreement is acceptable; no TPS impact.

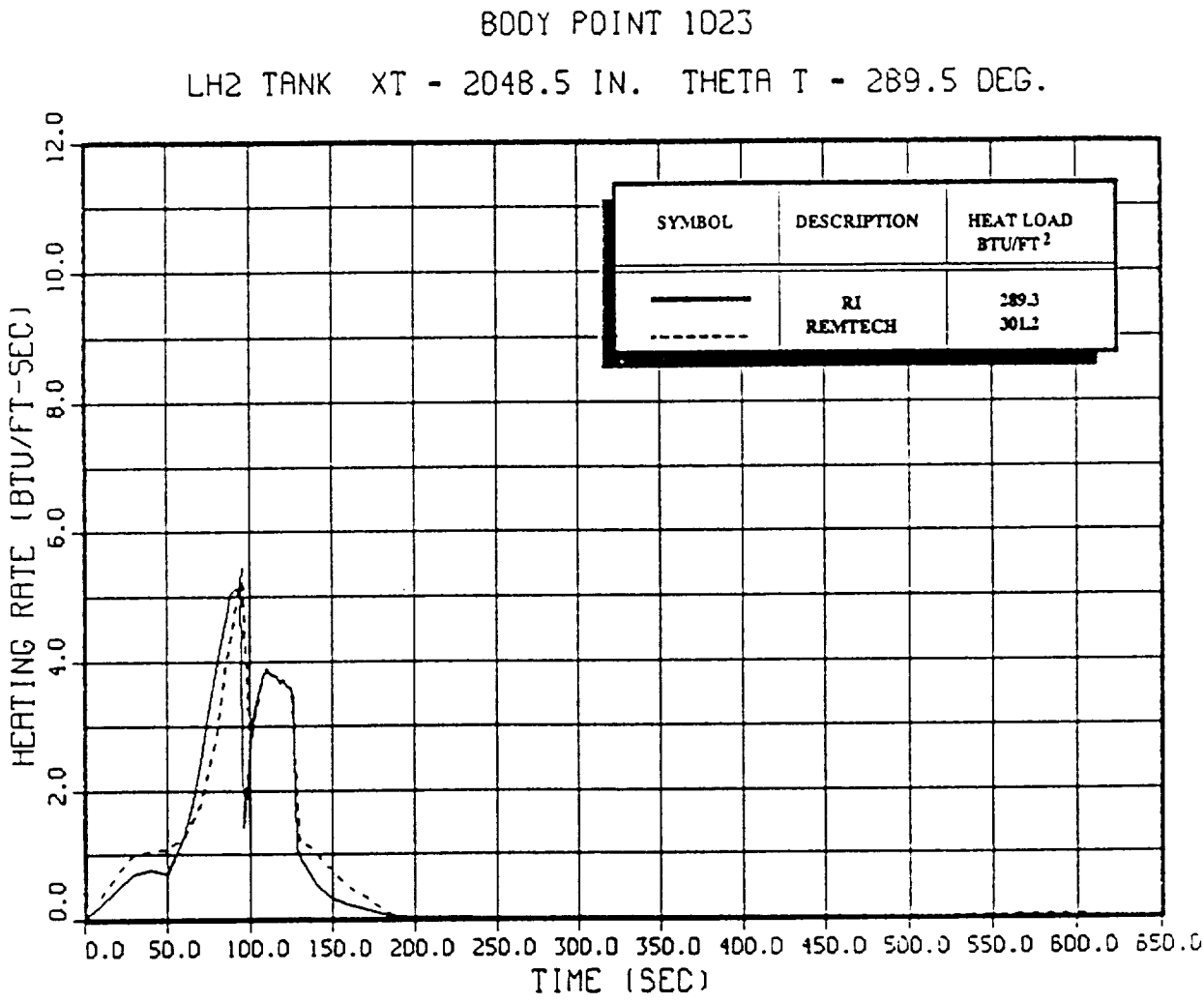


Agreement is acceptable; no TPS impact.

ASCENT DESIGN ENVIRONMENTS FOR THE ET LH_2 TANK ACREAGE BODY POINT LOCATIONS



Agreement is acceptable; no TPS impact.



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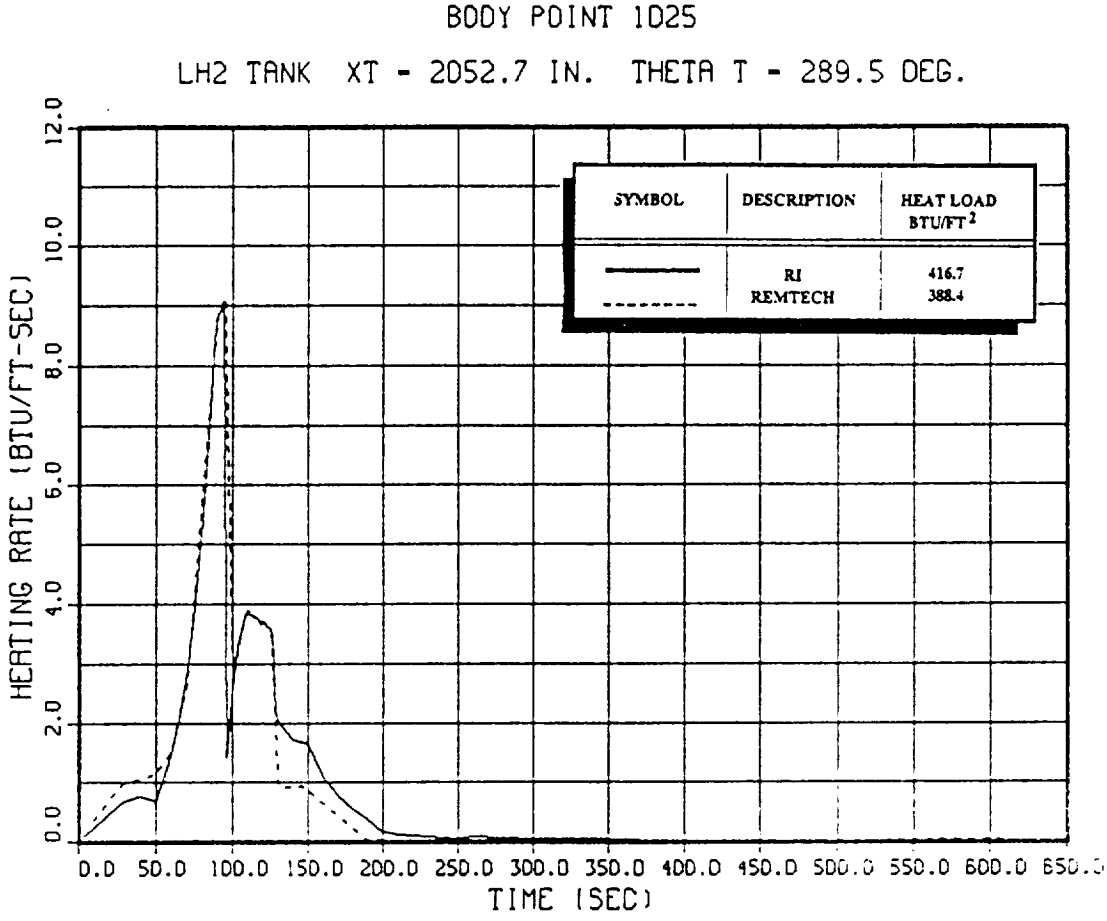
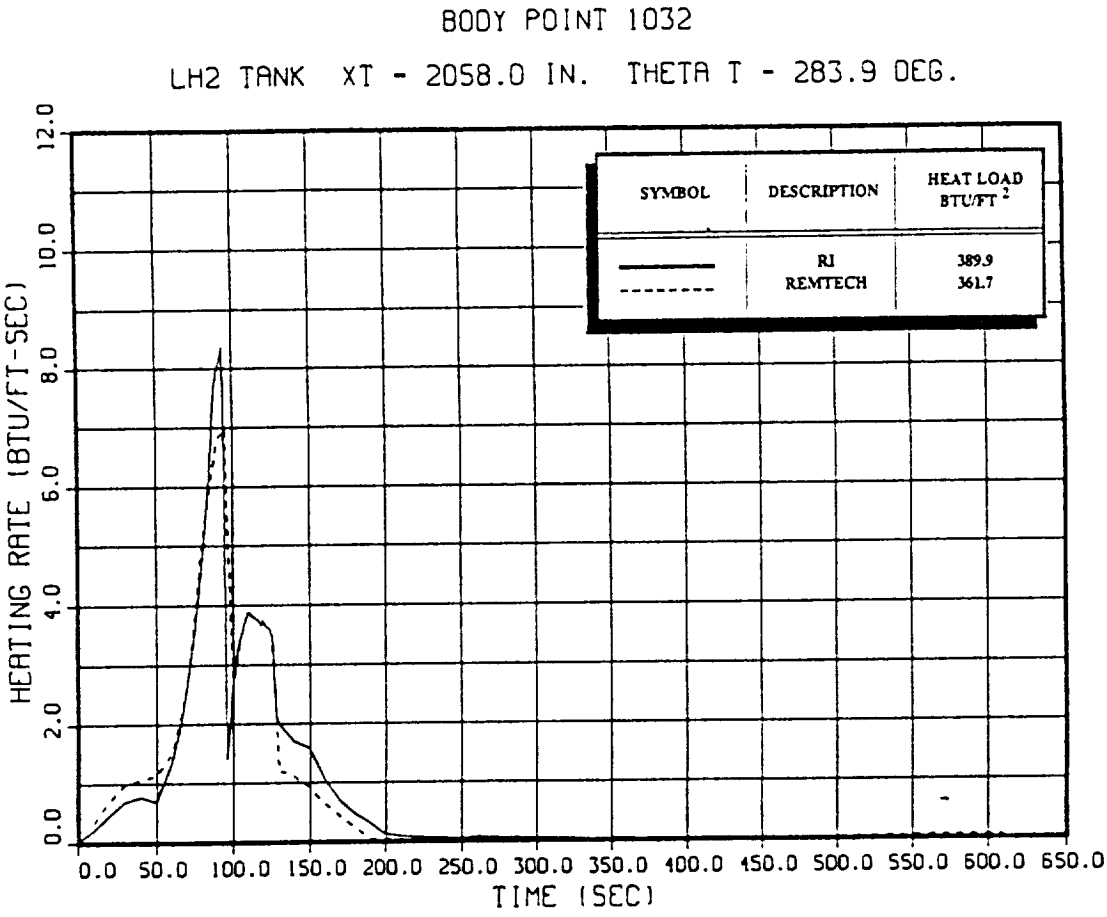


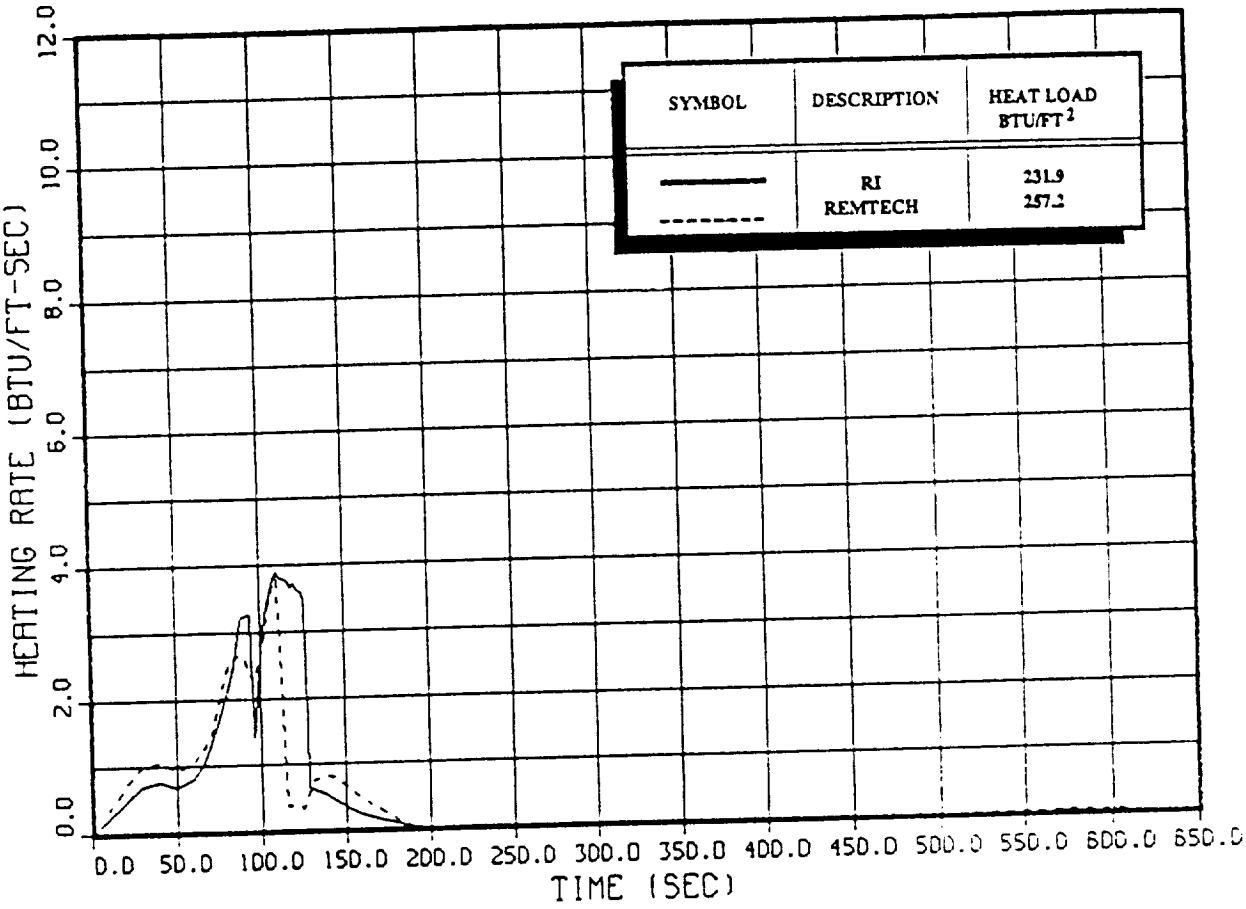
Agreement is acceptable; no TPS impact.



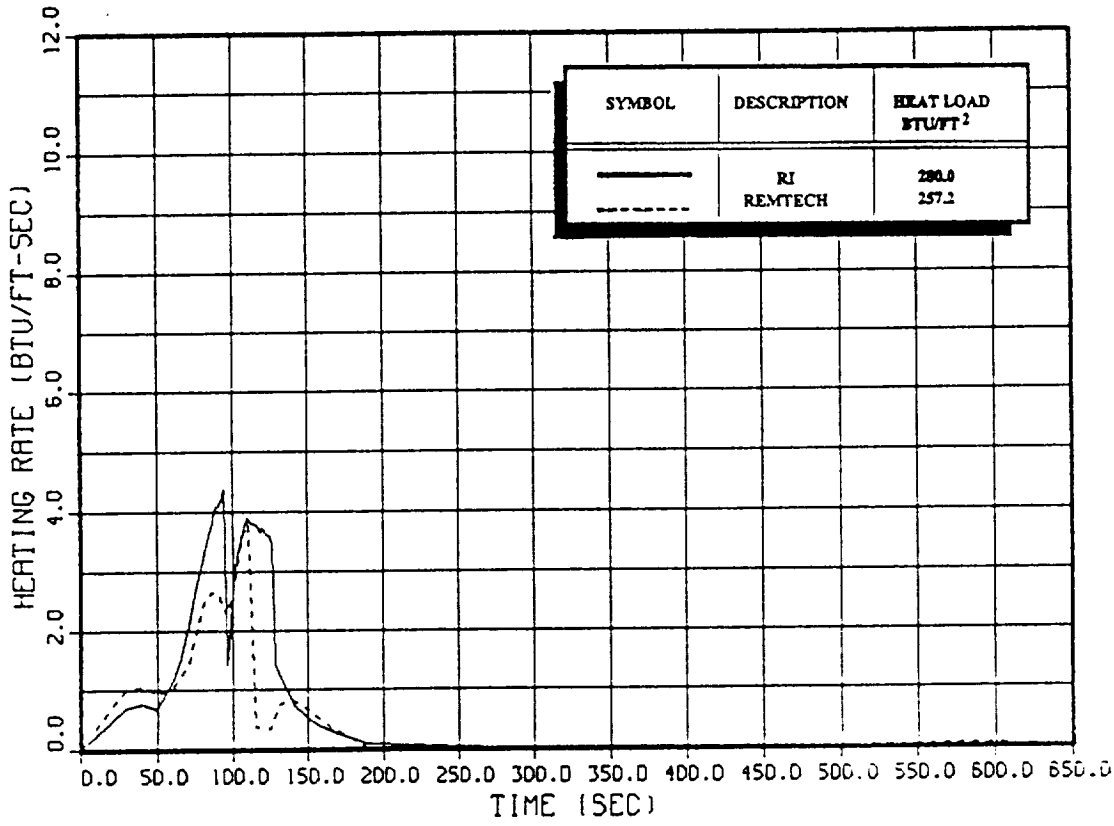
Agreement is acceptable; no TPS impact.

BODY POINT 1041

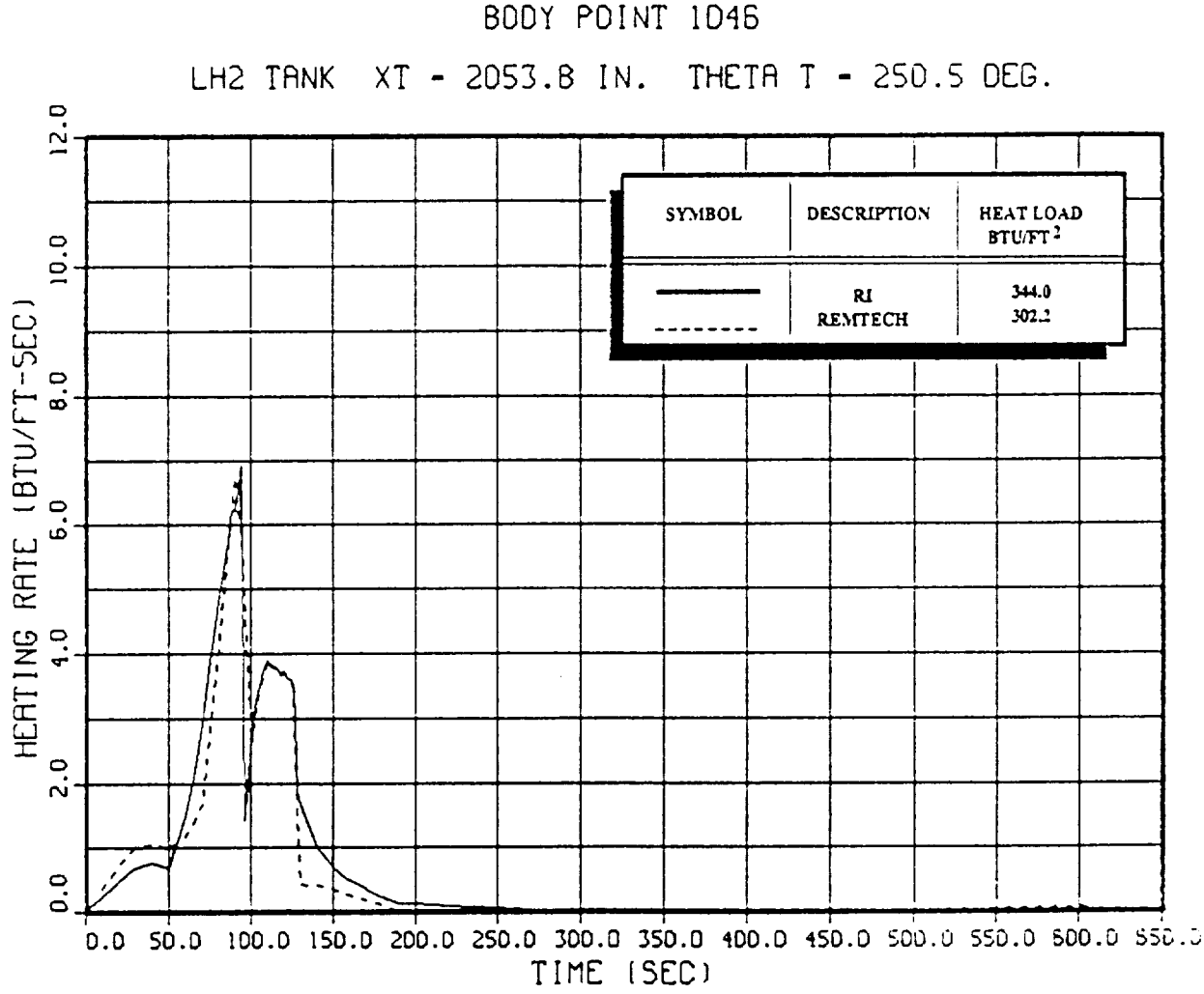
LH2 TANK XT - 2040.8 IN. THETA T - 250.5 DEG.



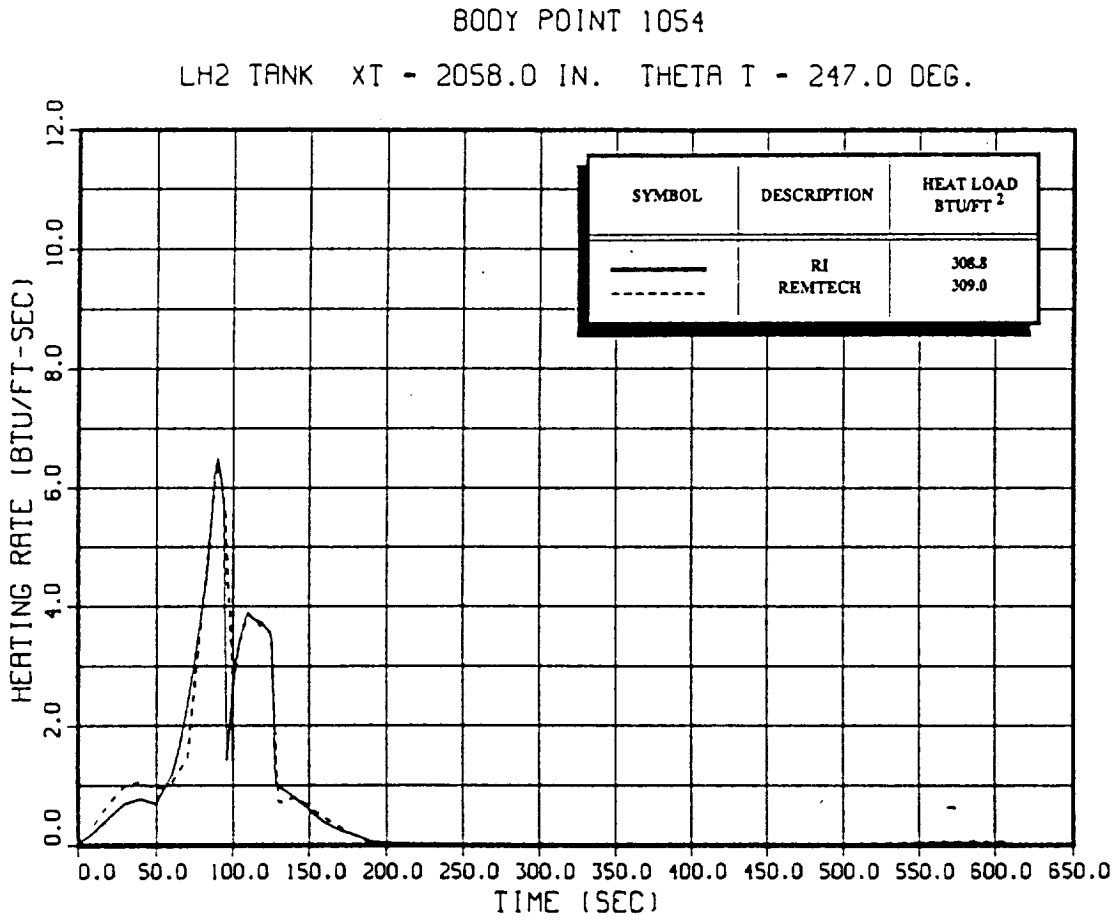
Agreement is acceptable; no TPS impact.



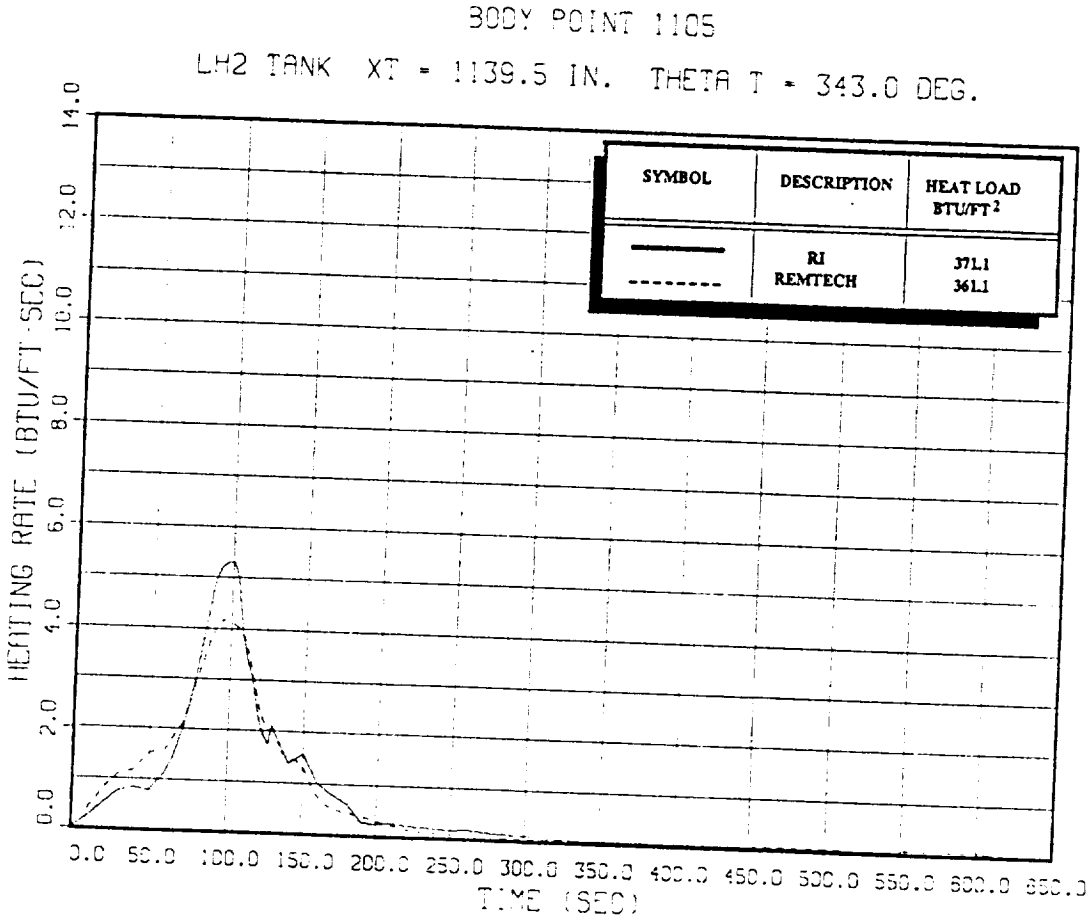
Agreement is acceptable; no TPS impact.



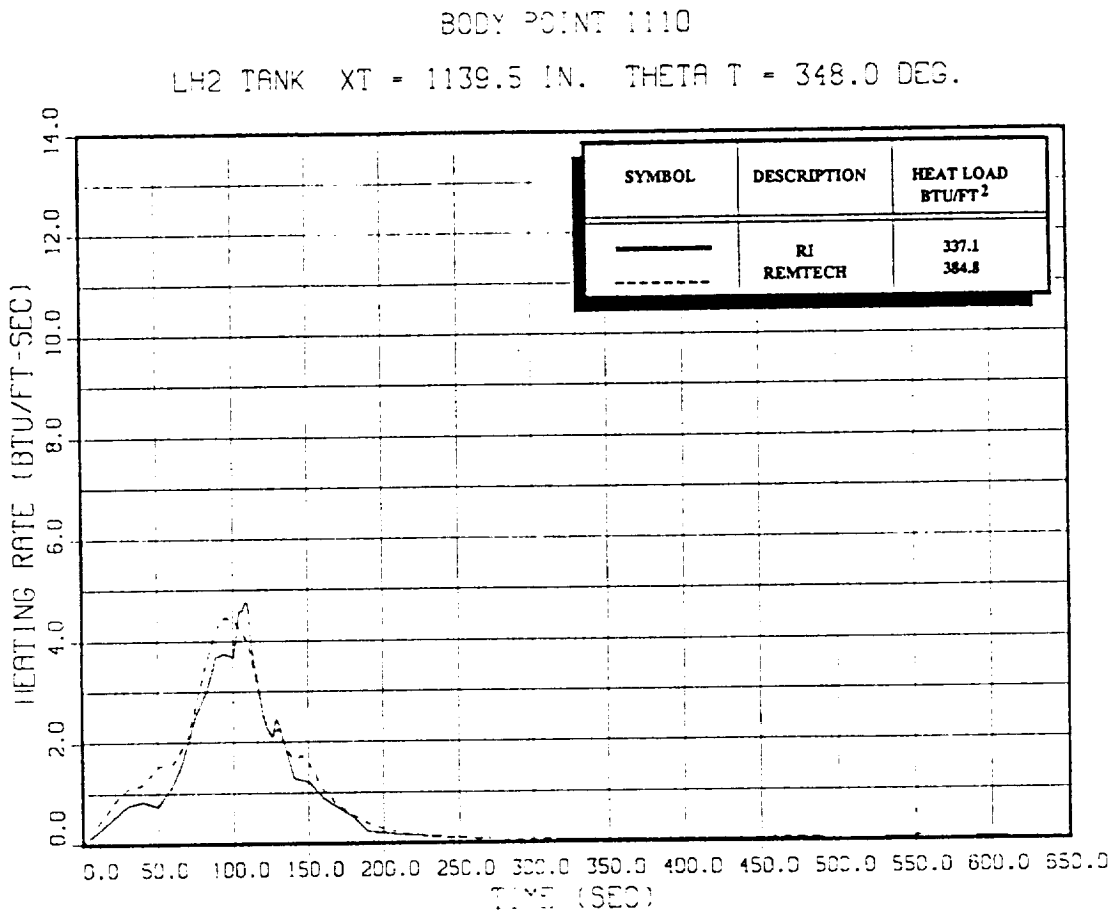
Agreement is acceptable; no TPS impact.



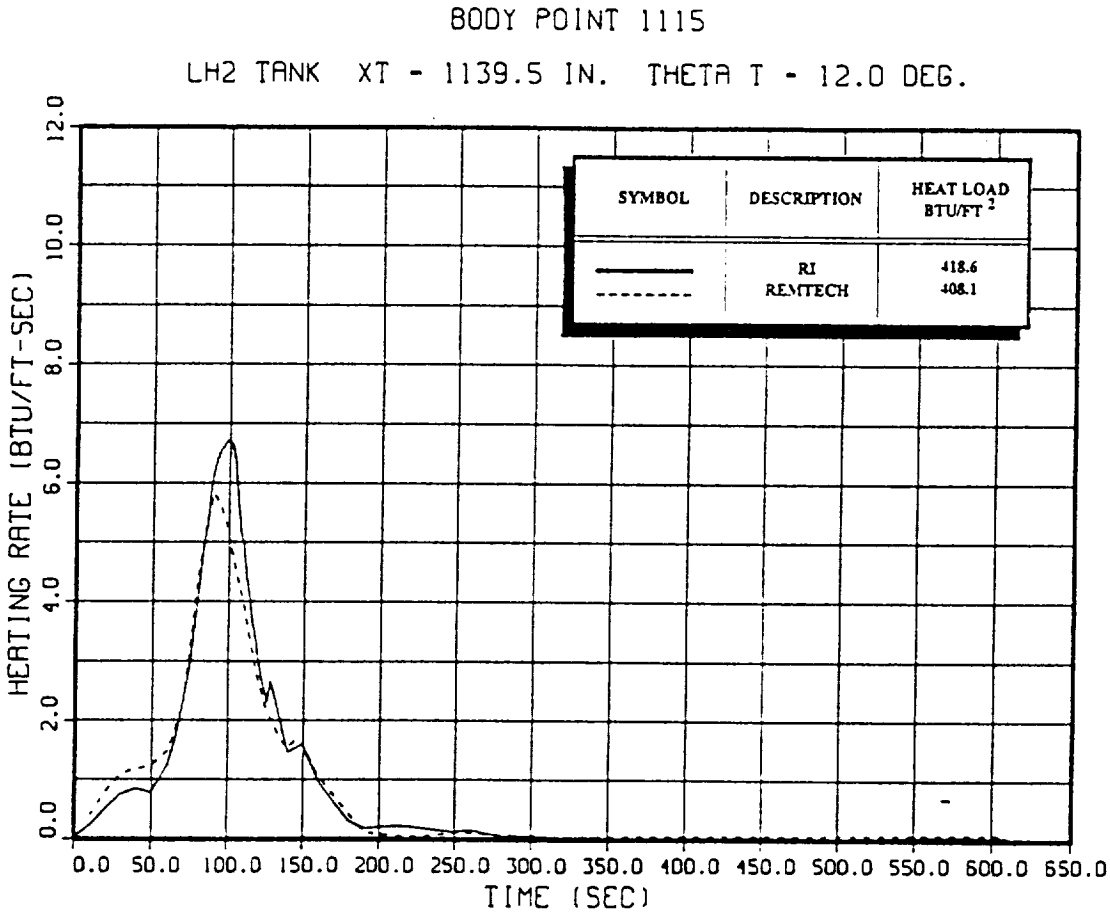
Agreement is acceptable; no TPS impact.



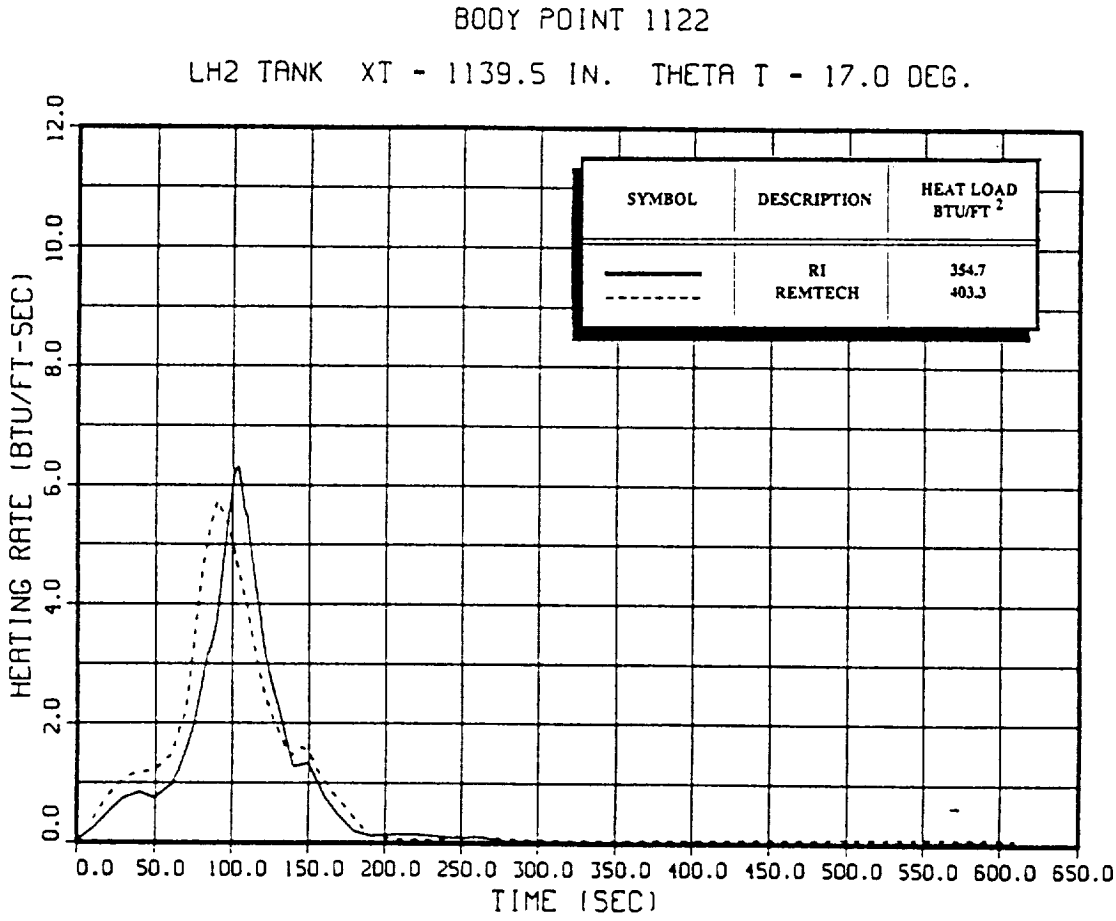
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



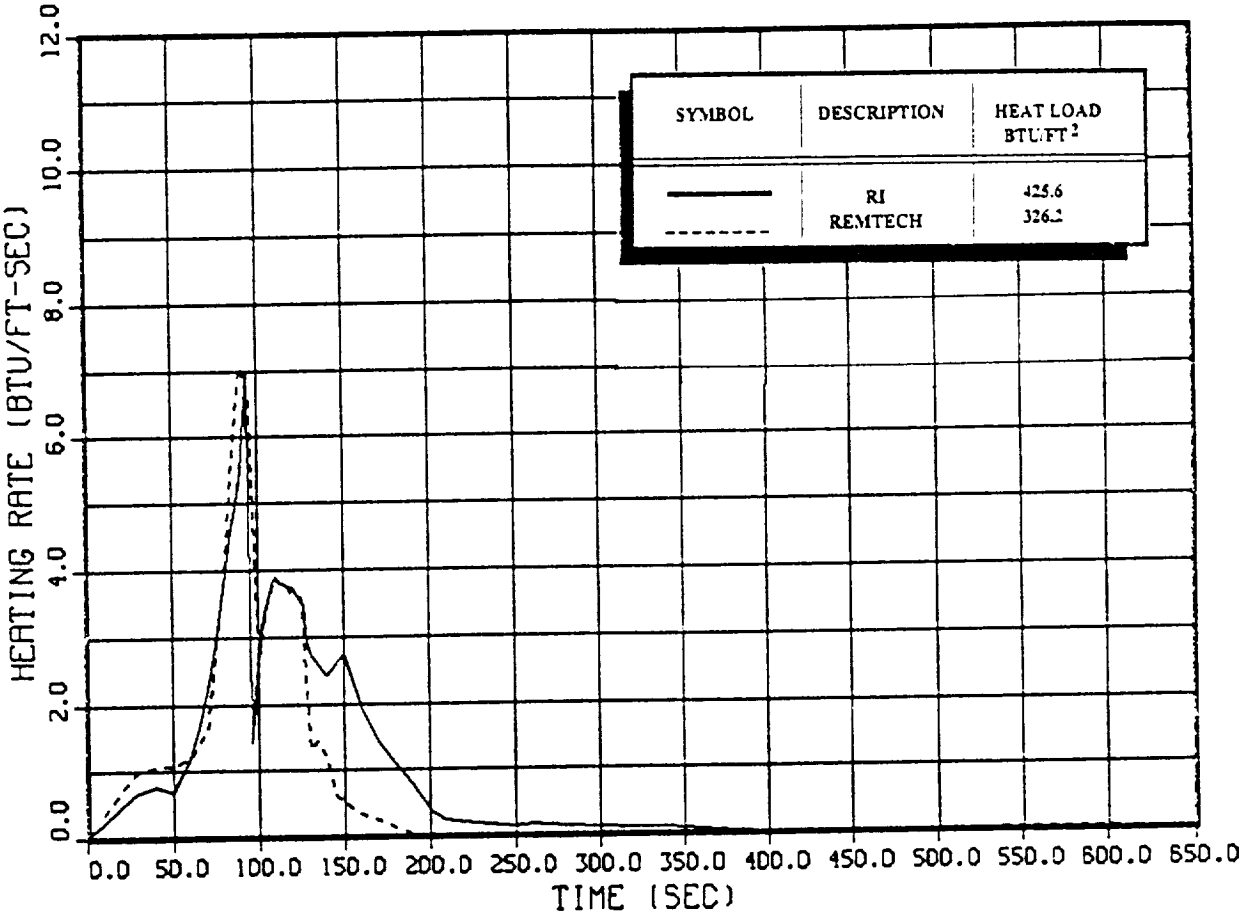
Agreement is acceptable; no TPS impact.



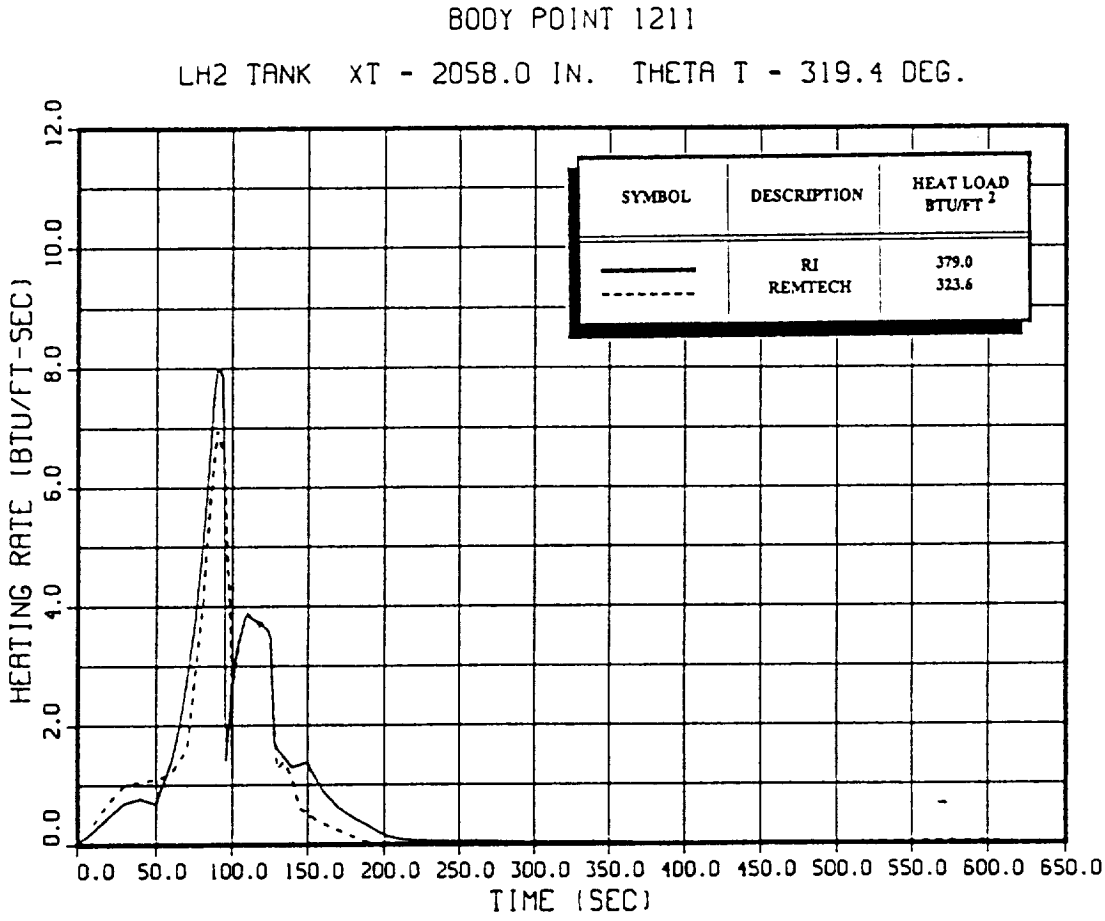
Agreement is acceptable; no TPS impact.

BODY POINT 1205

LH2 TANK XT = 2053.50 IN. THETA T = 312.6 DEG.



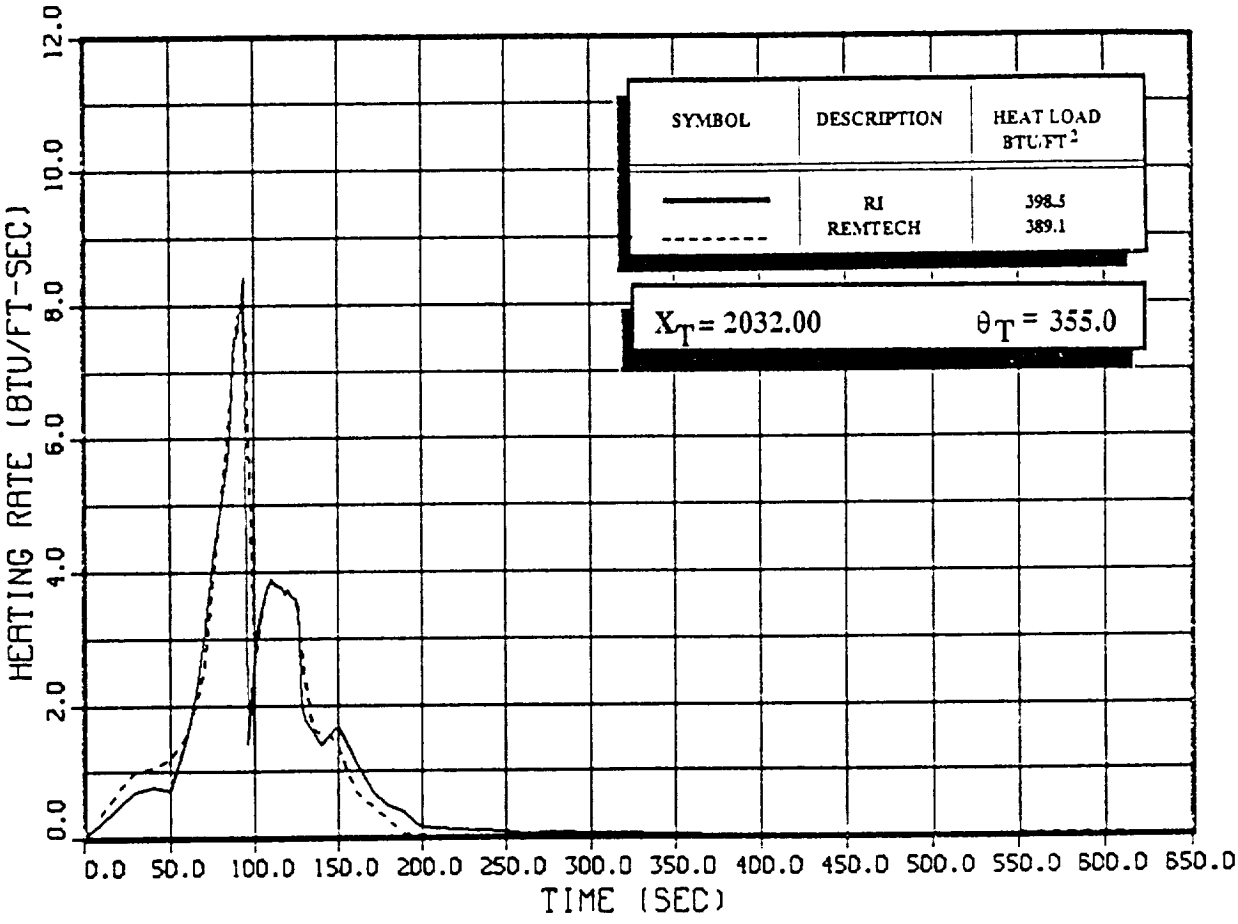
Agreement is acceptable; no TPS impact.



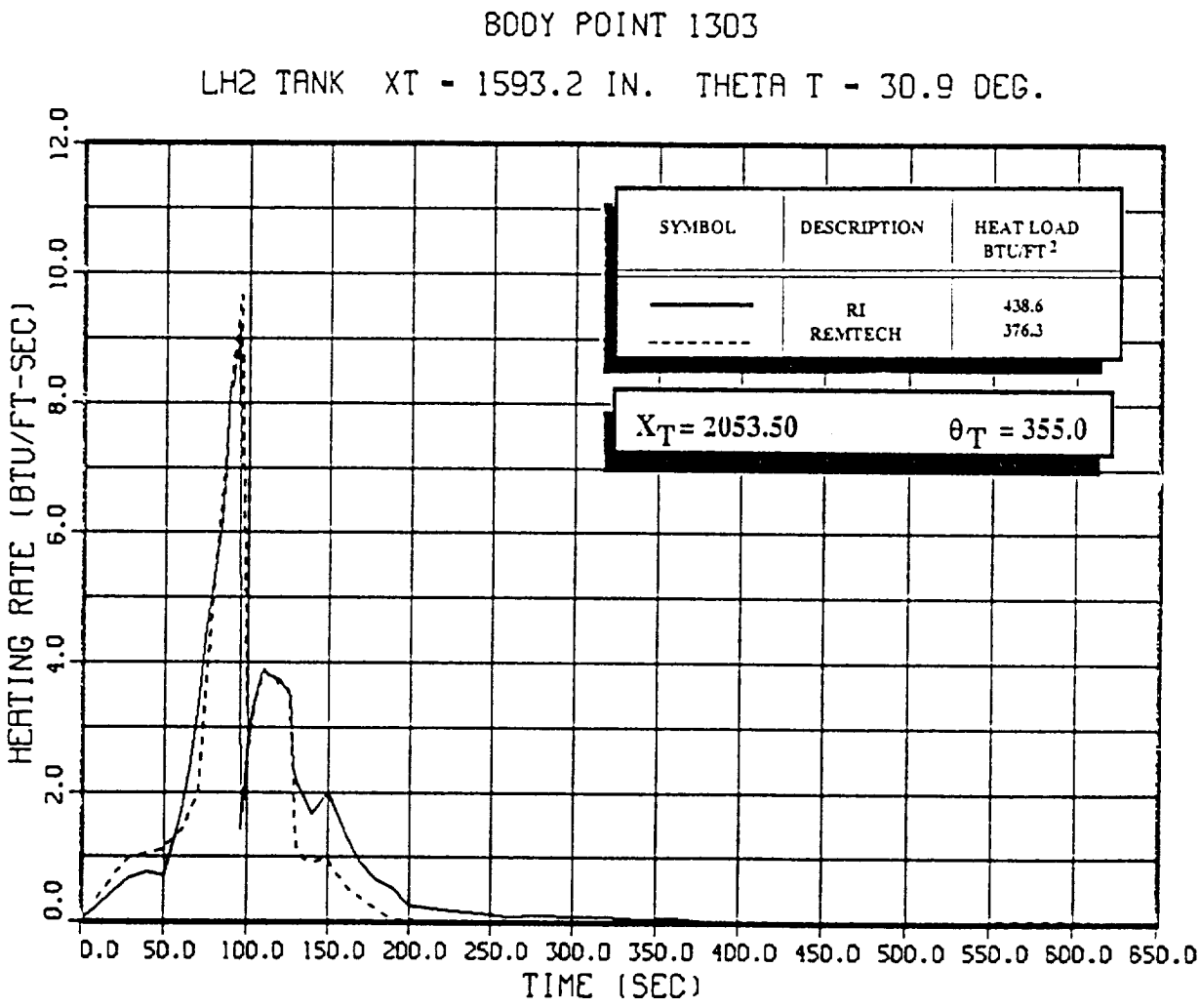
Agreement is acceptable; no TPS impact.

BODY POINT 1300

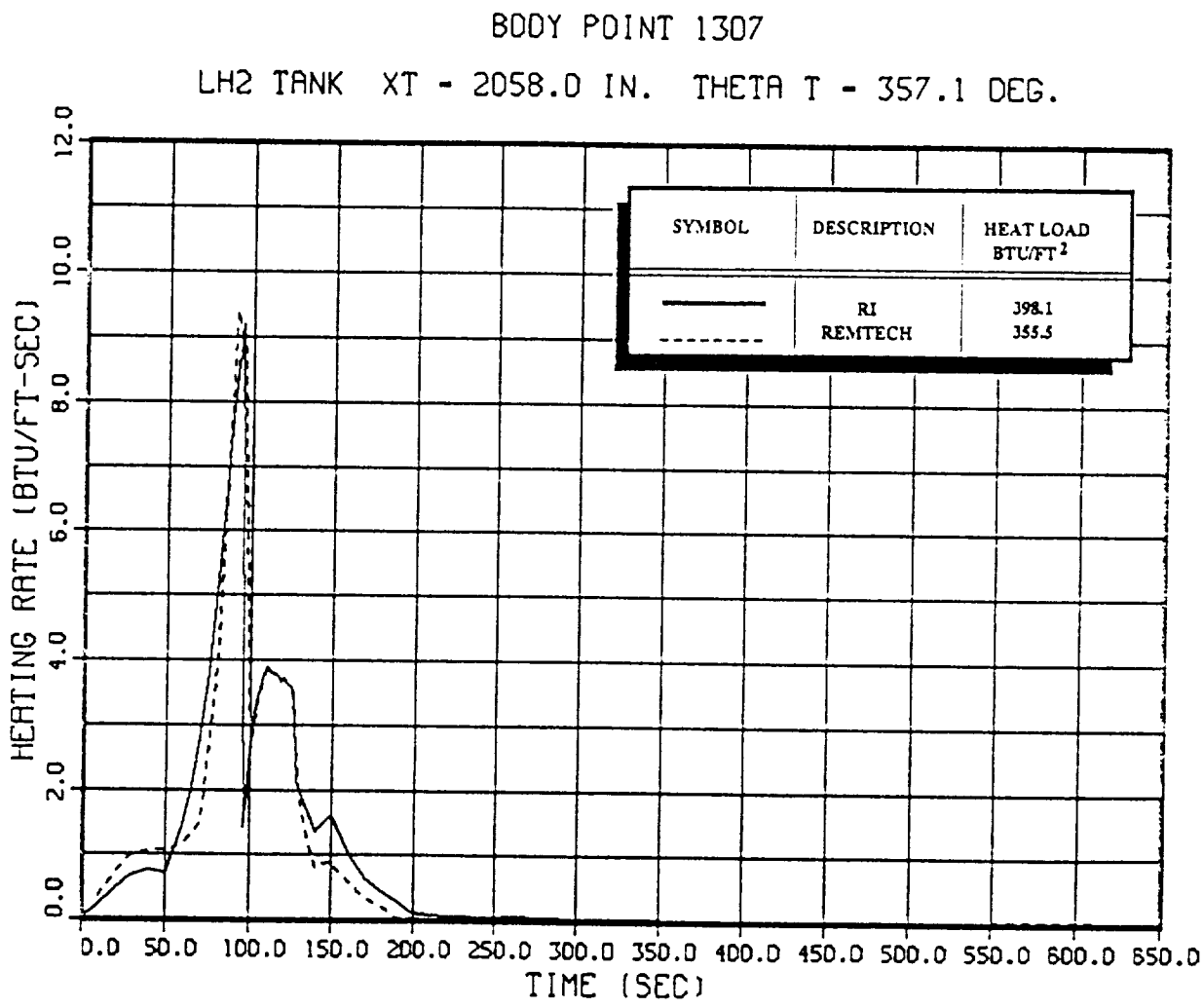
LH2 TANK XT - 1593.2 IN. THETA T - 30.9 DEG.



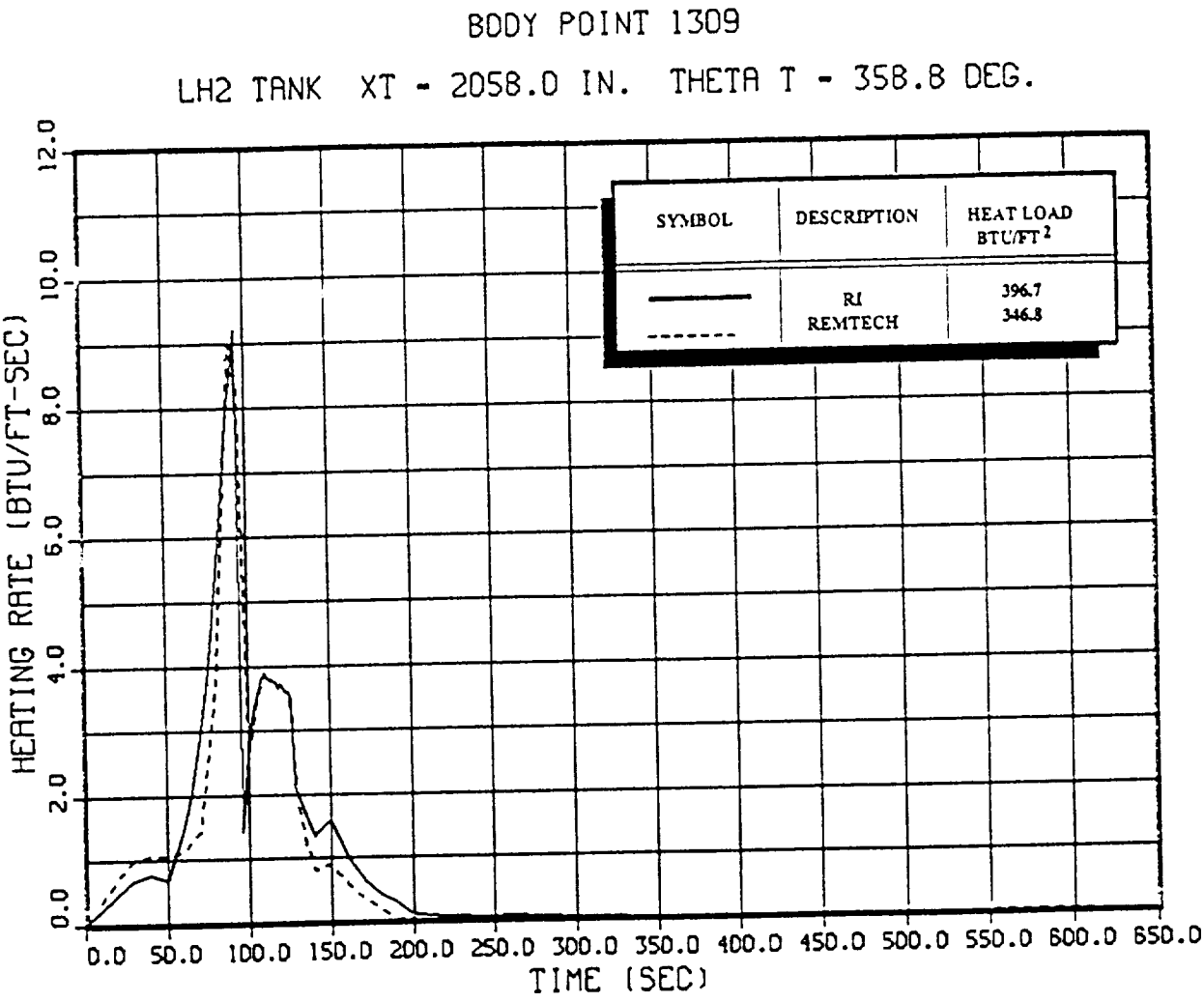
Agreement is acceptable; no TPS impact.



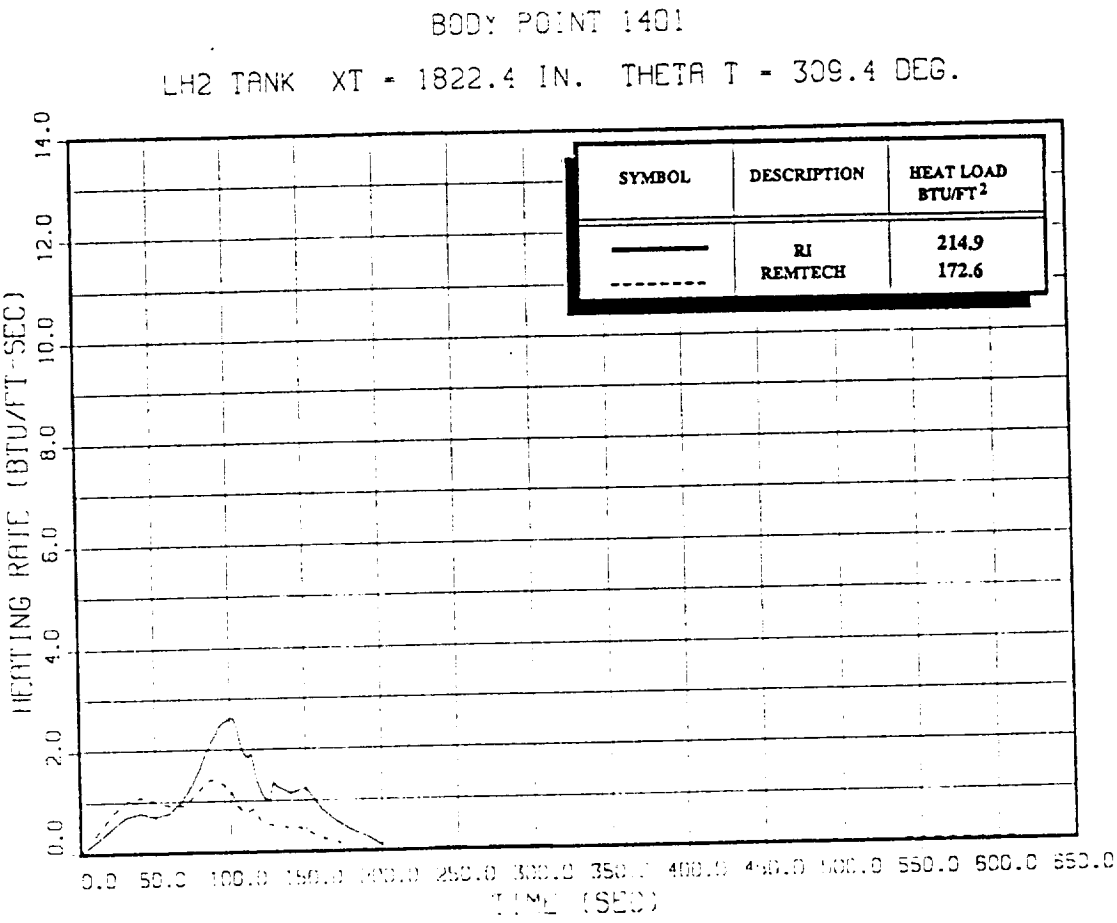
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.

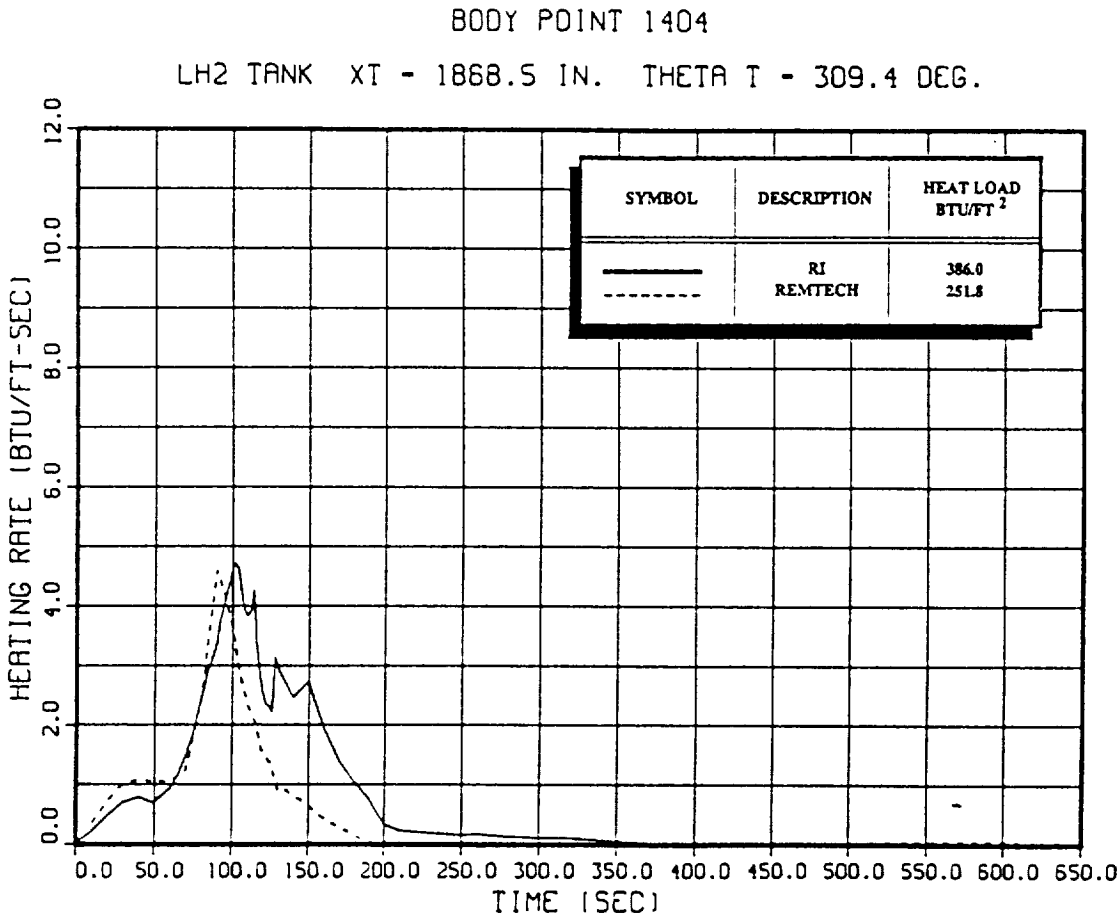


Agreement is acceptable; no TPS impact.

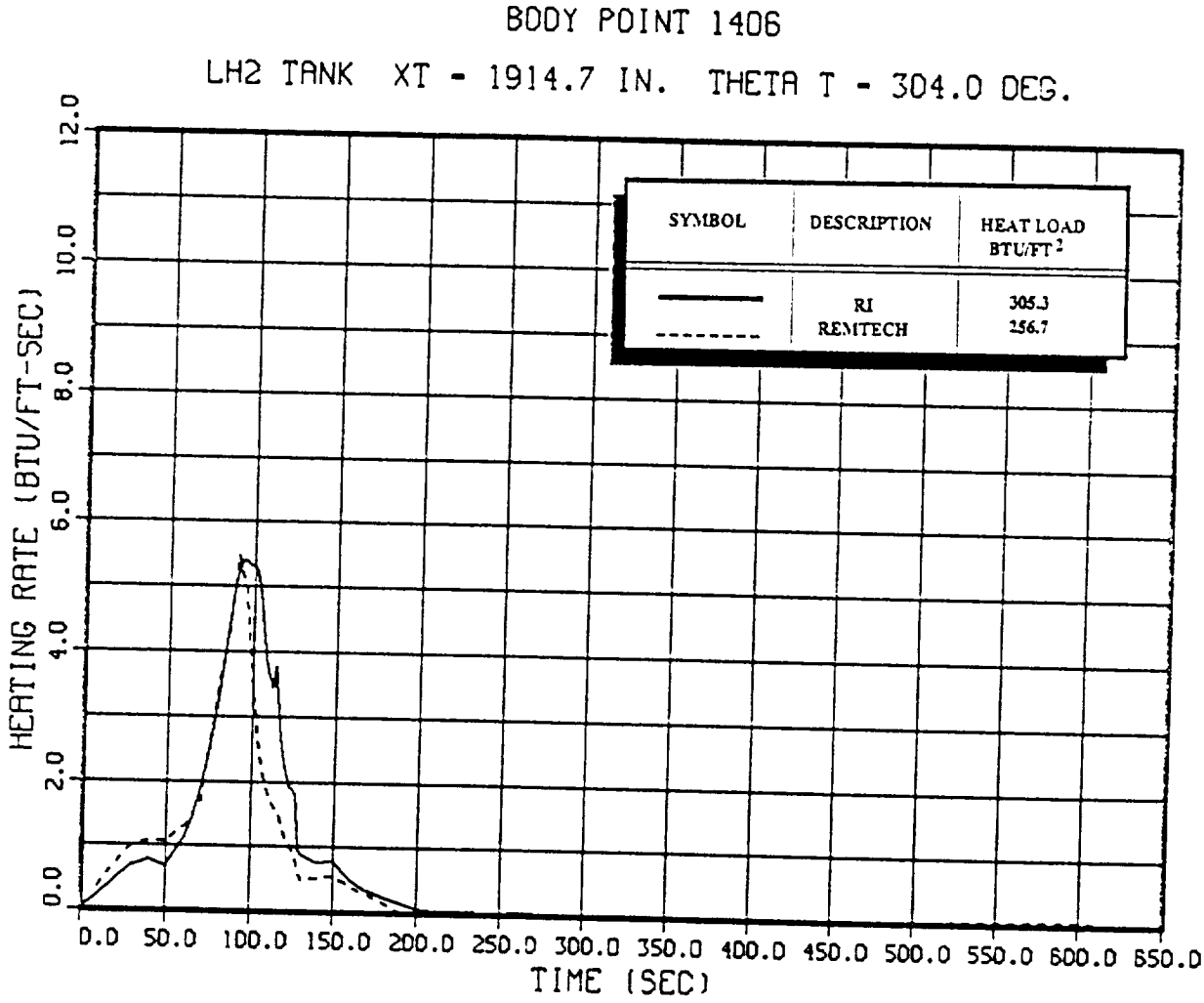


- RI IVBC-3 considered high from a consistency standpoint with surrounding environments. Hi/Hu factors are high compared with the IH-97 data base (T/C 5252).

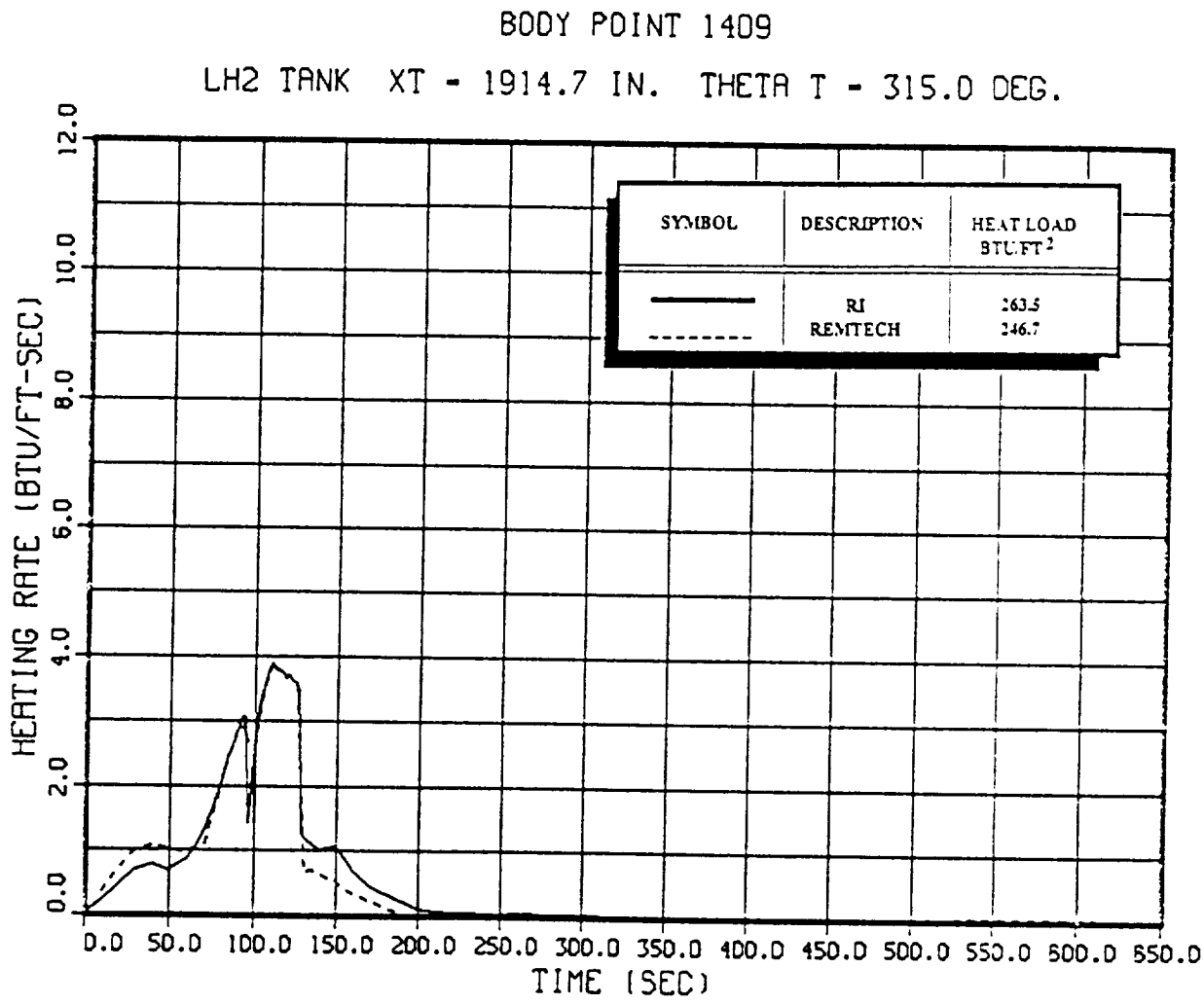
Agreement is acceptable; no TPS impact.



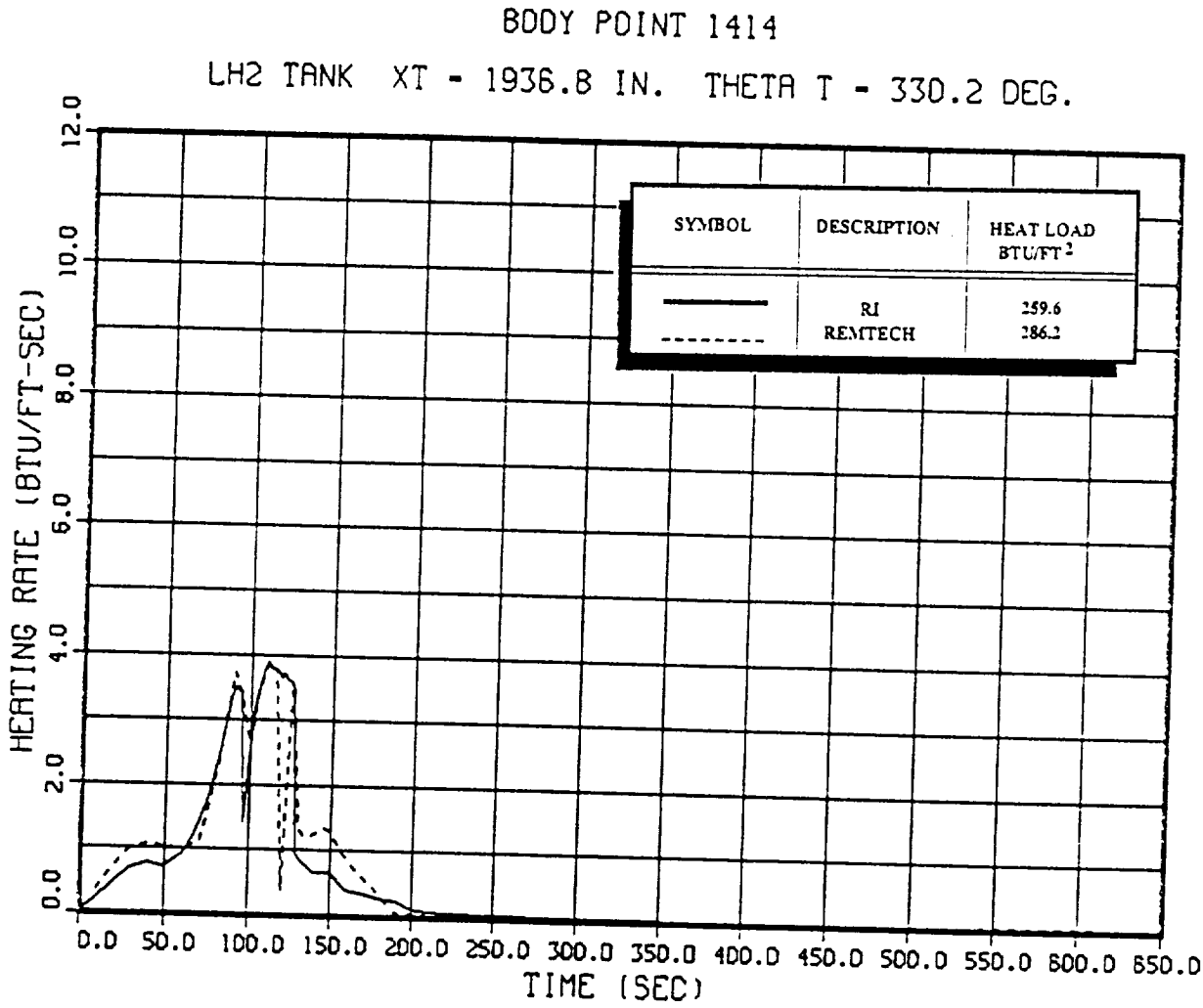
Agreement is acceptable; no TPS impact.



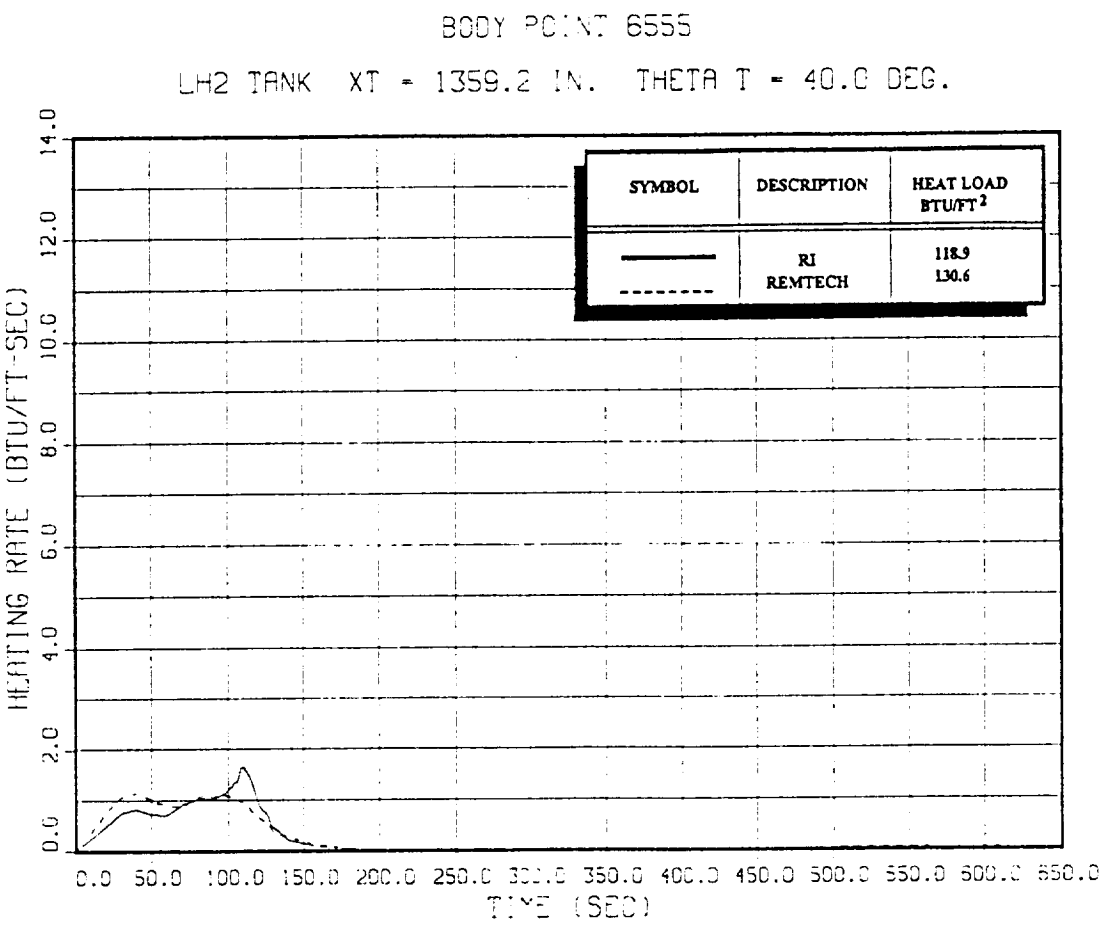
Agreement is acceptable; no TPS impact.



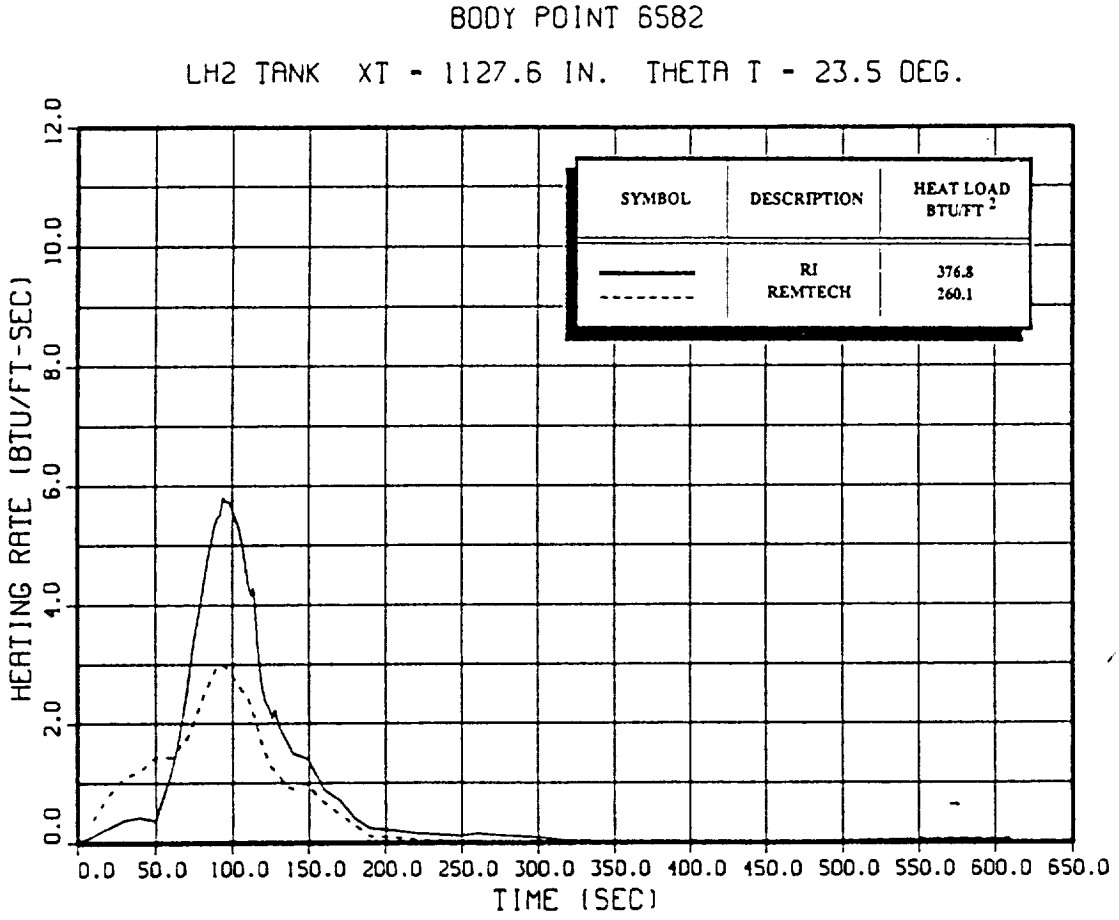
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.

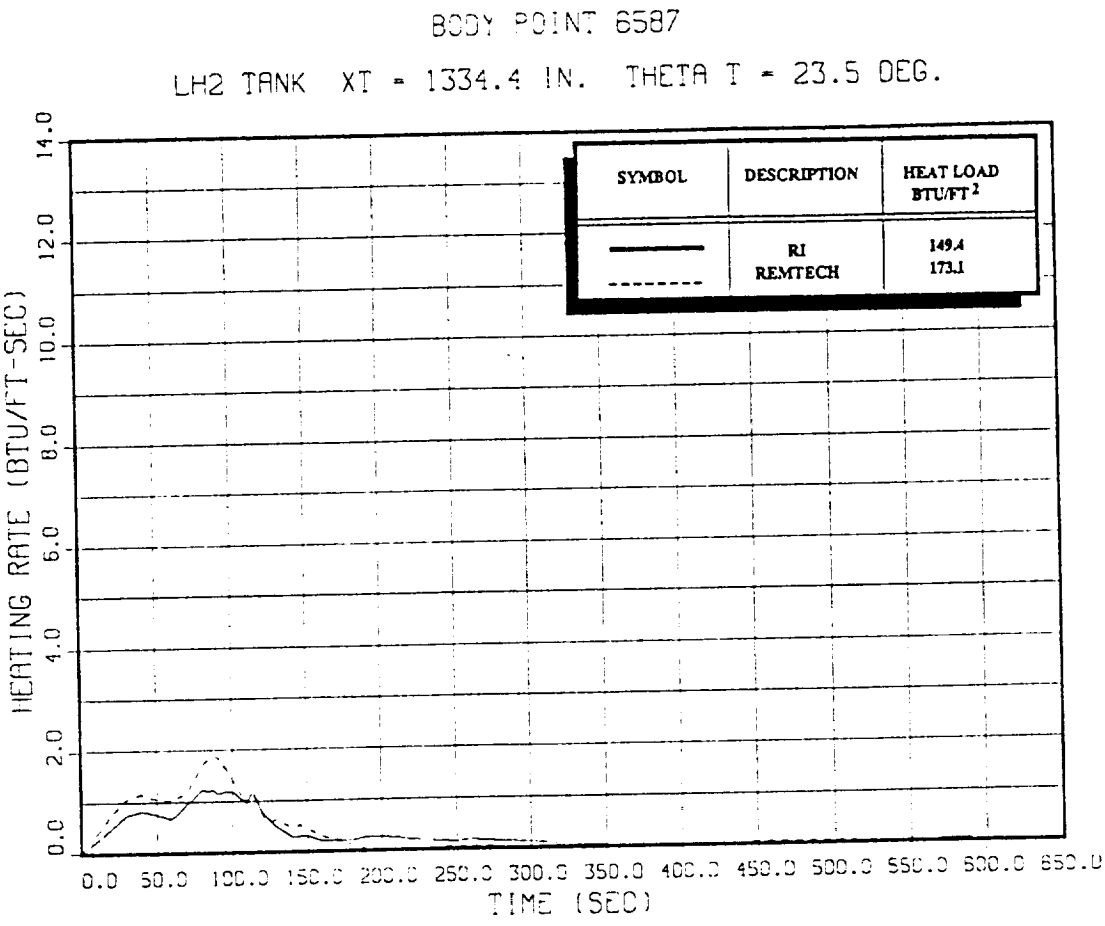


Agreement is acceptable; no TPS impact.



- RI IVBC-3 environments considered high. B.P. 6582 is located under the LO_2 feed line. Max rates at other similar locations range from 1 to 3 BTU/FT ^{2} sec.

Agreement is acceptable; no TPS impact.



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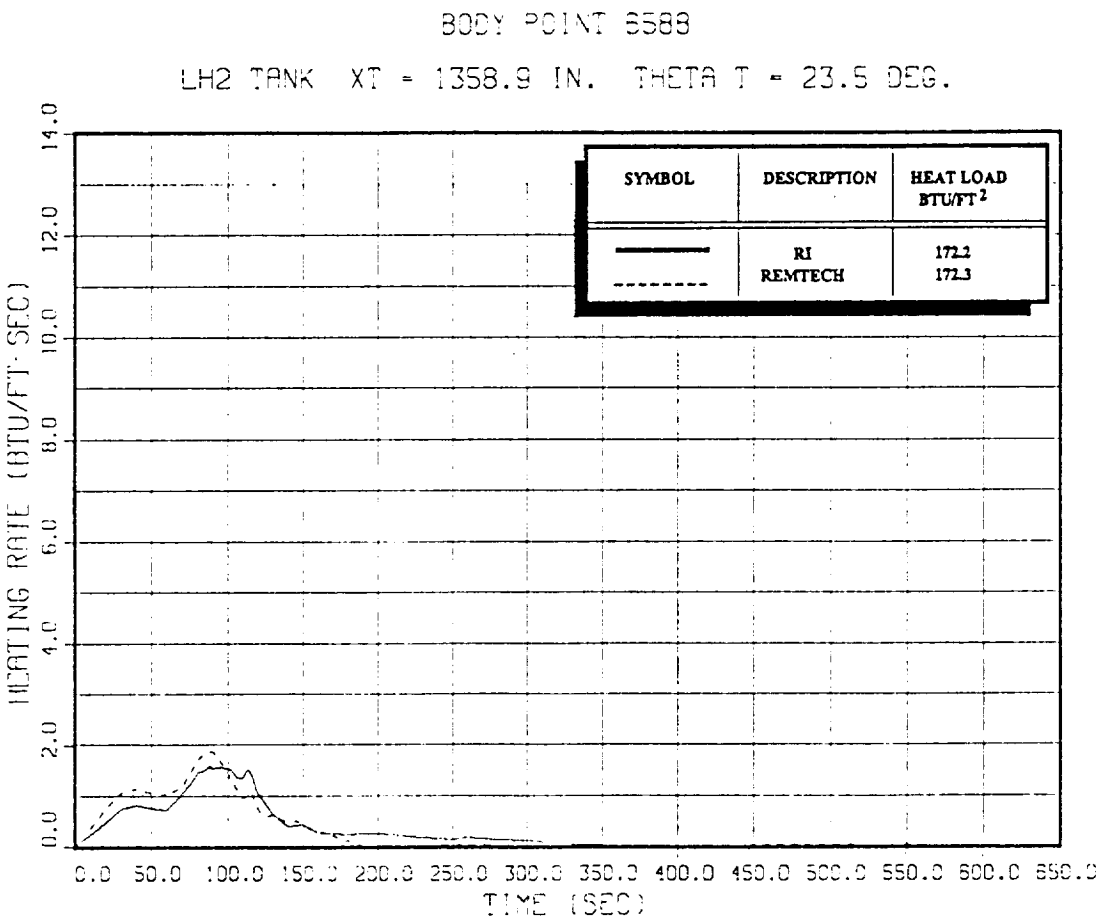
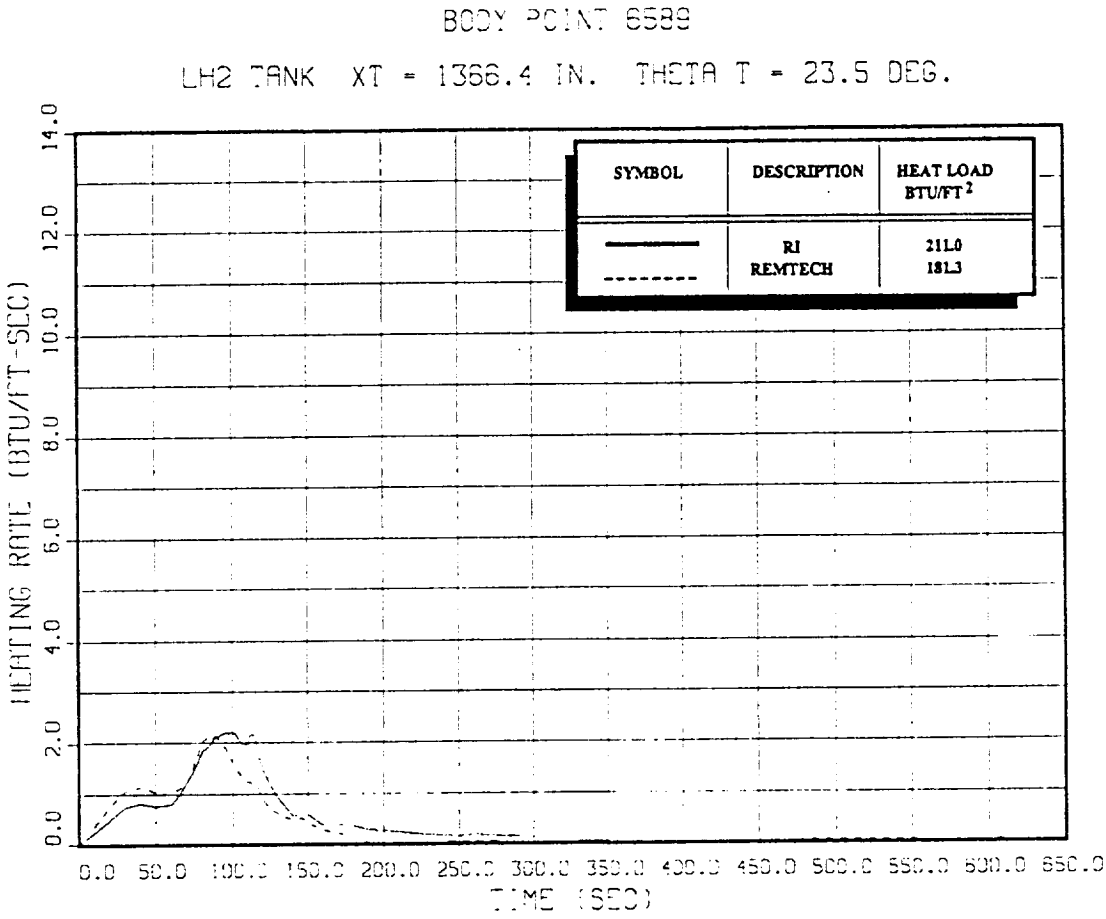
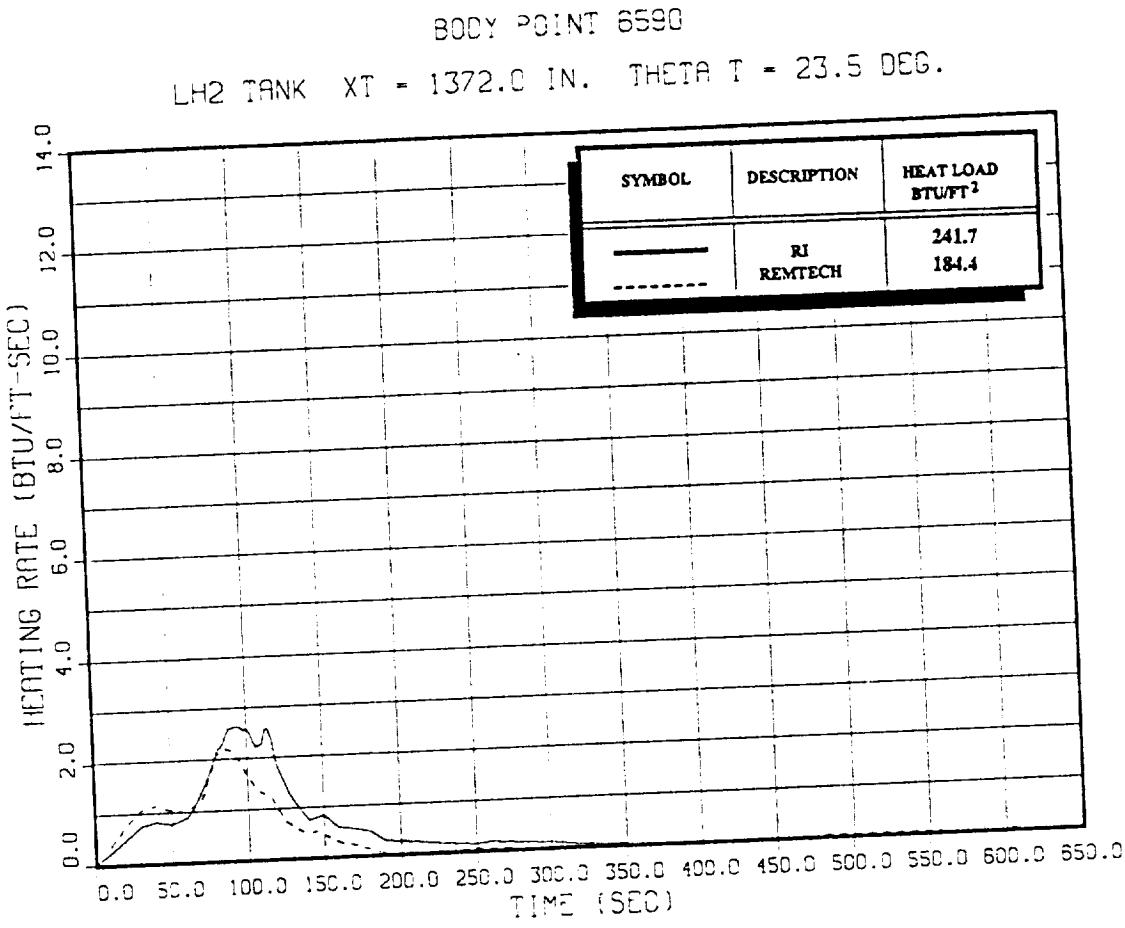


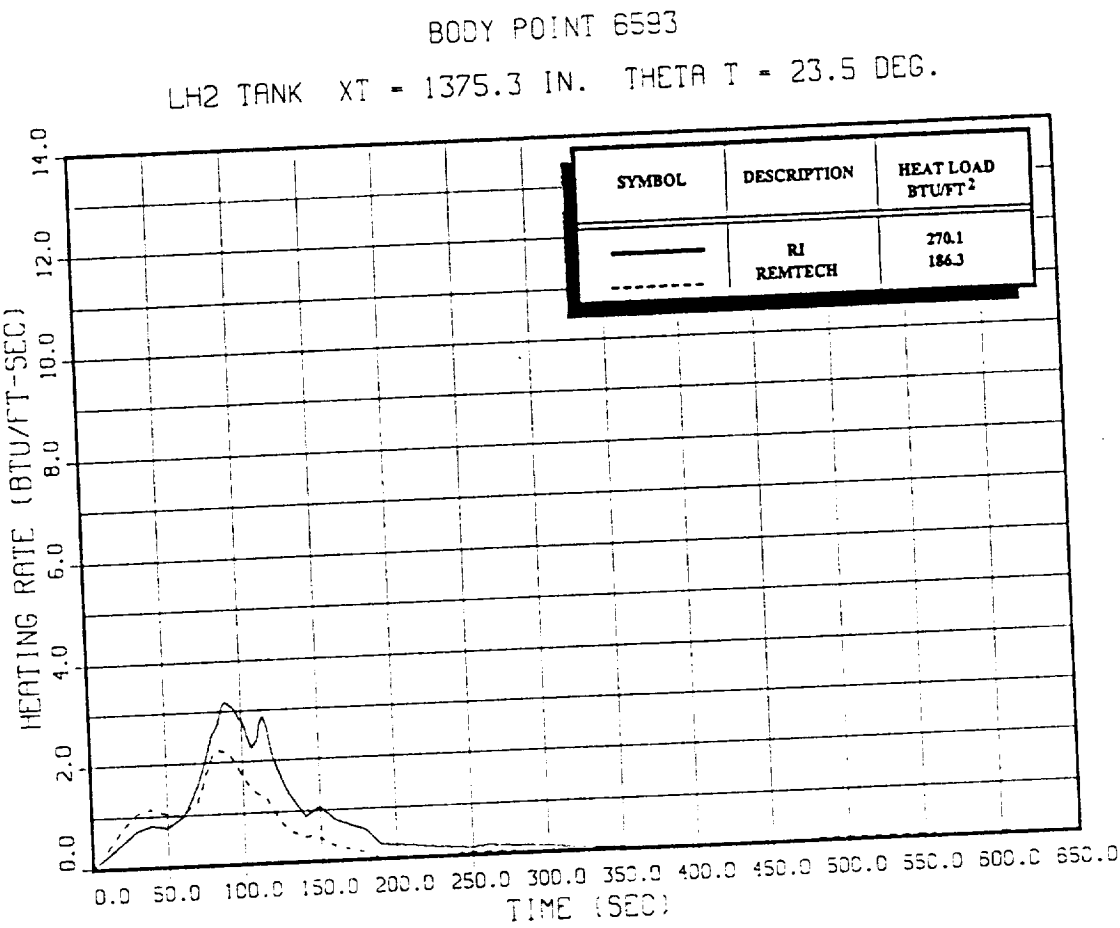
Agreement is acceptable; no TPS impact.



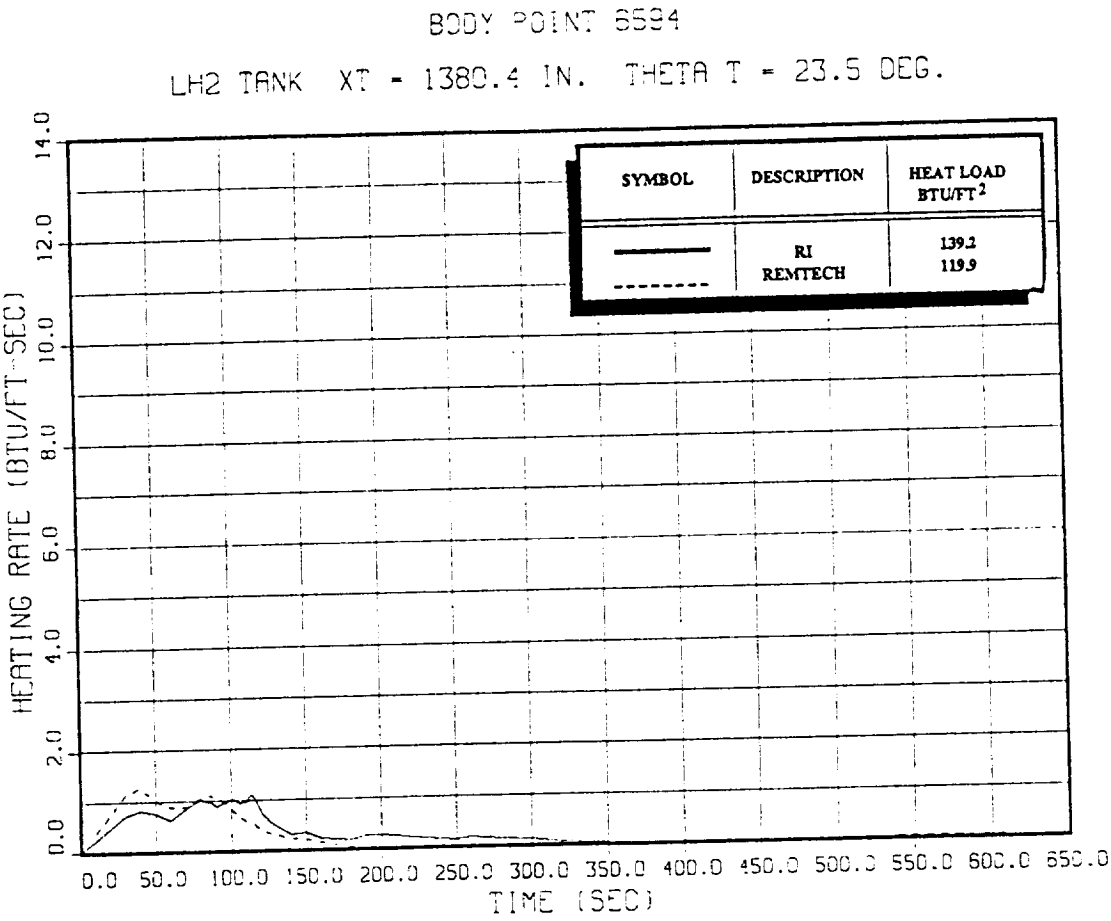
Agreement is acceptable; no TPS impact.



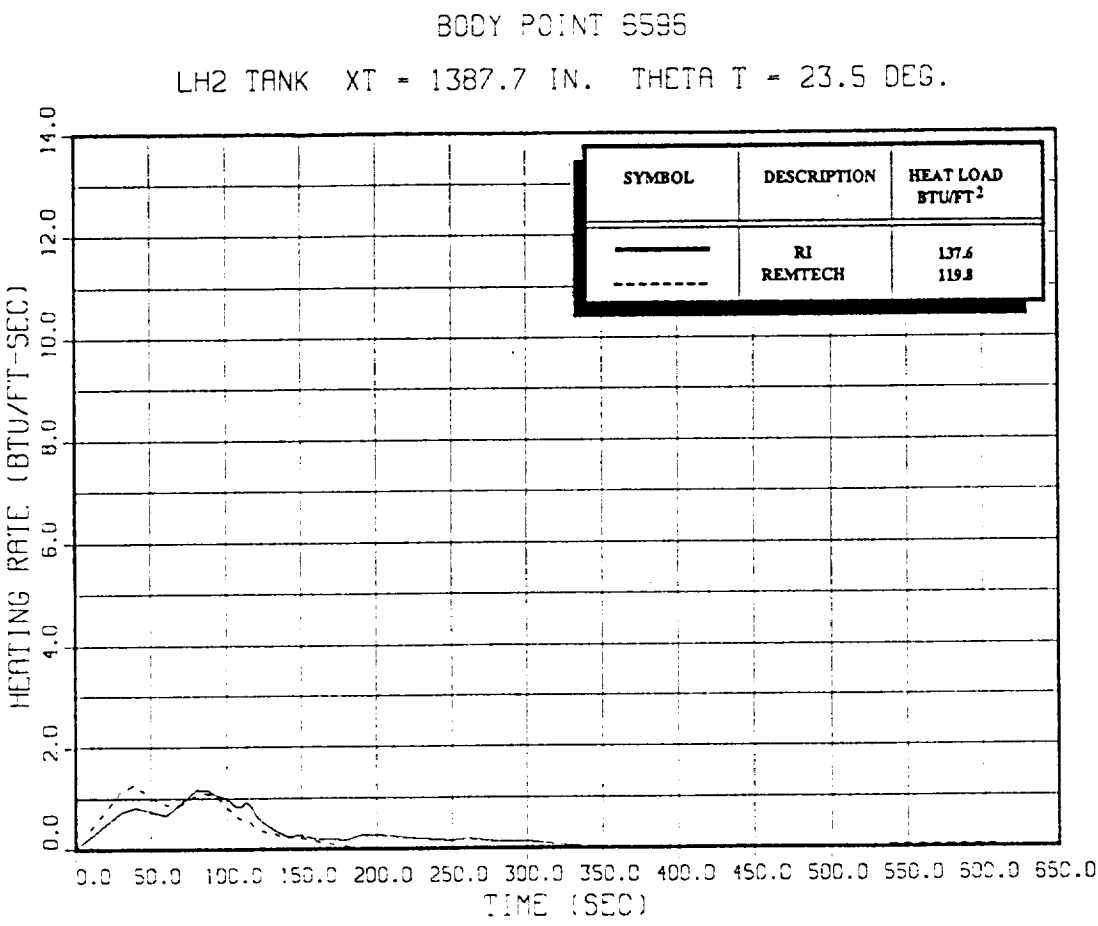
Agreement is acceptable; no TPS impact.



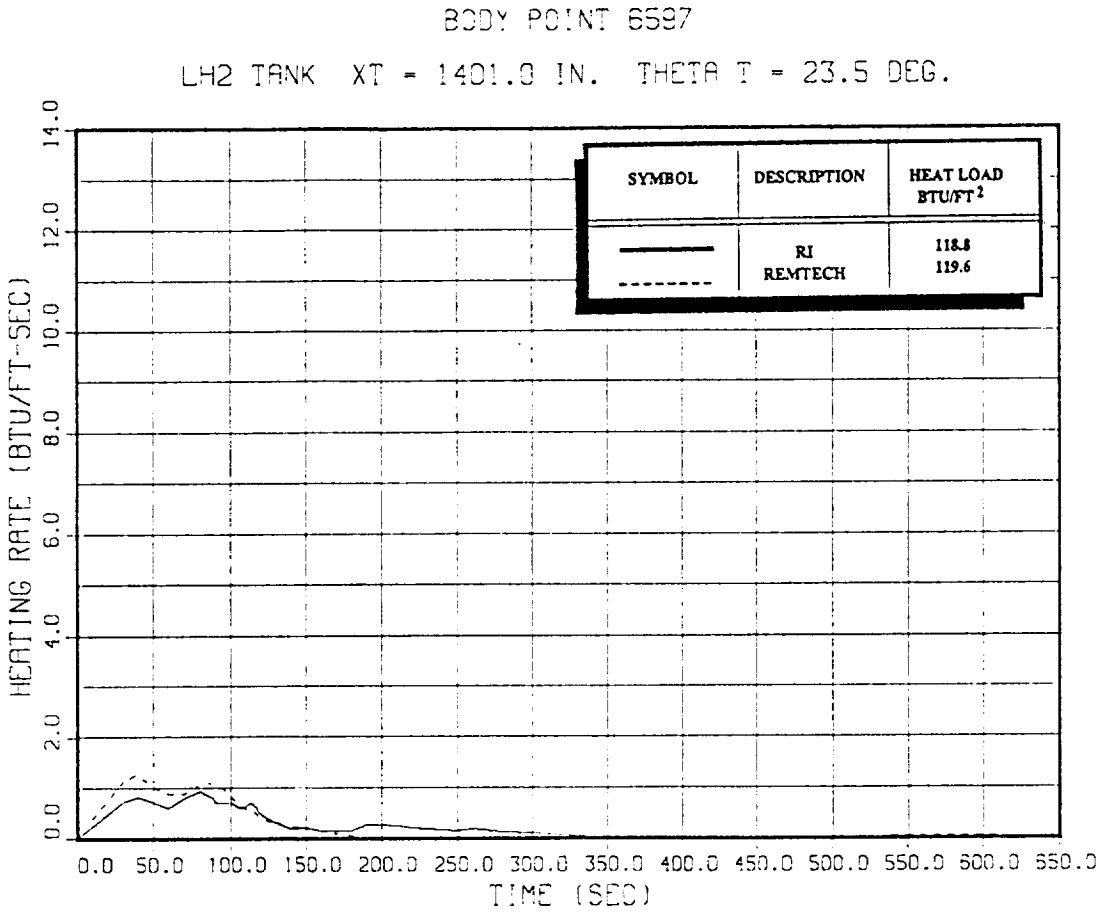
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



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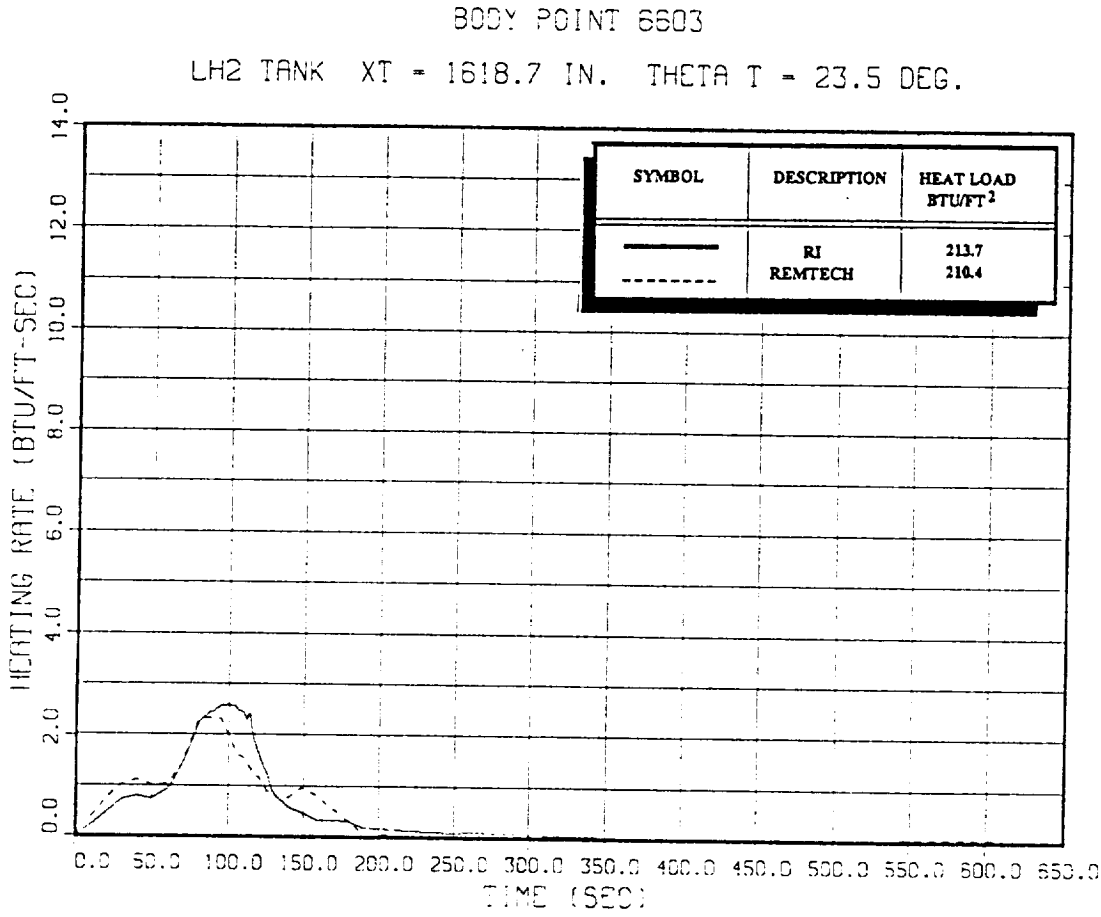

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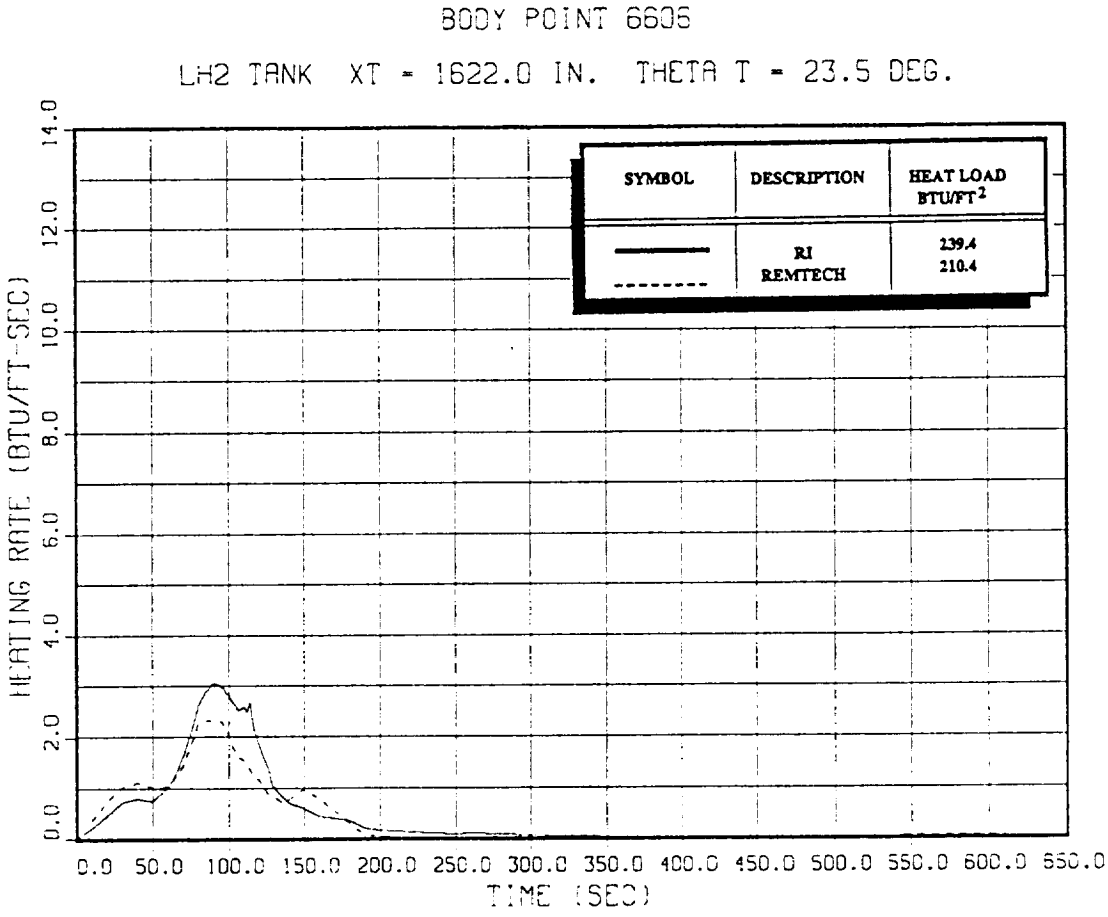

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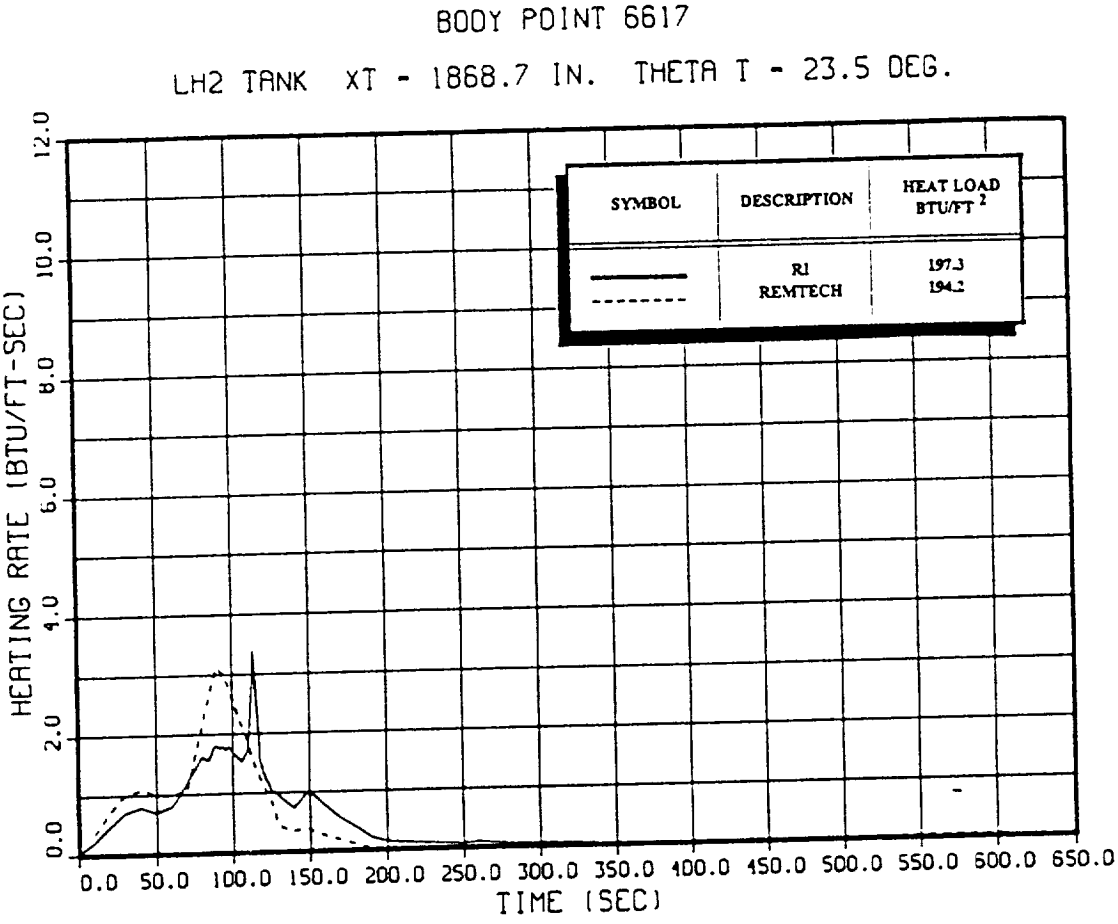
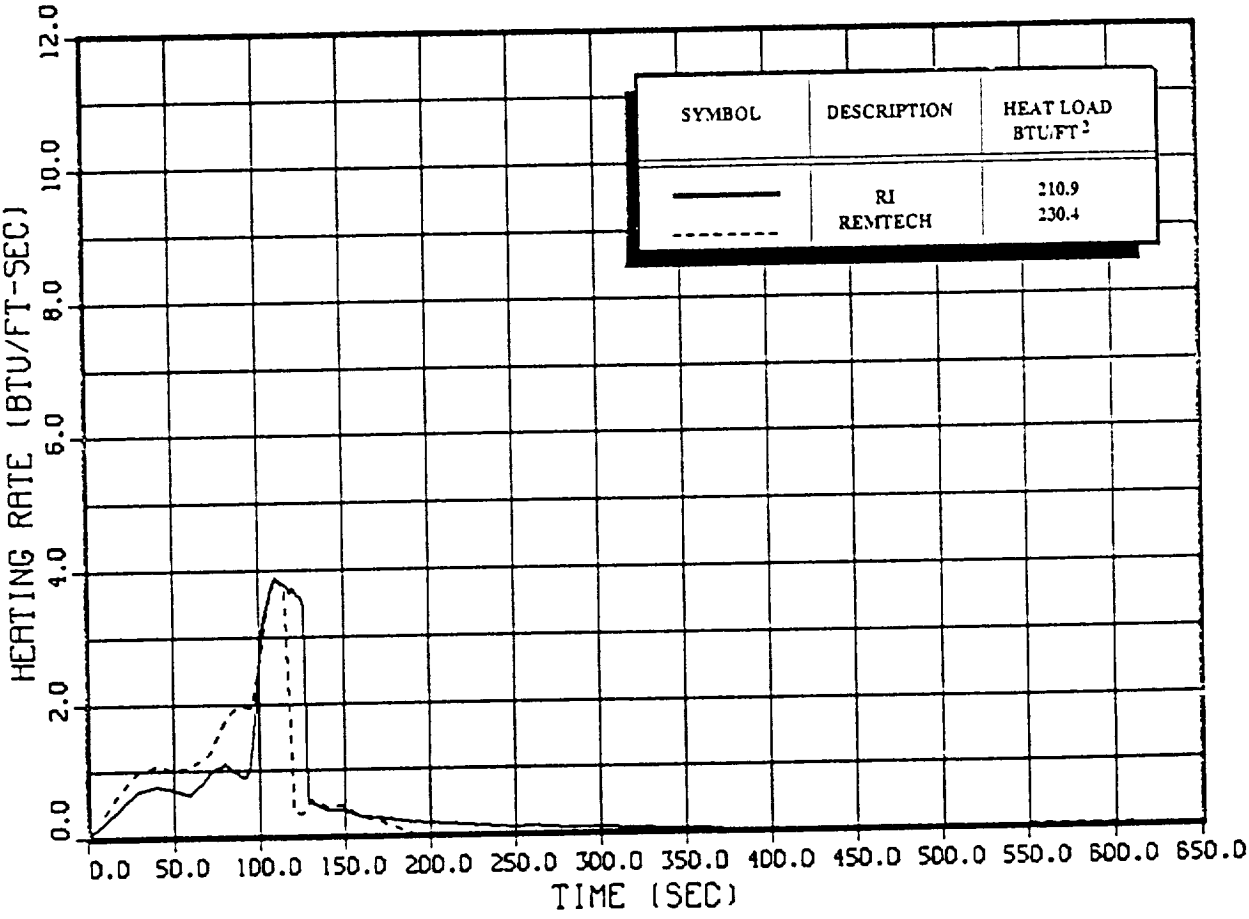


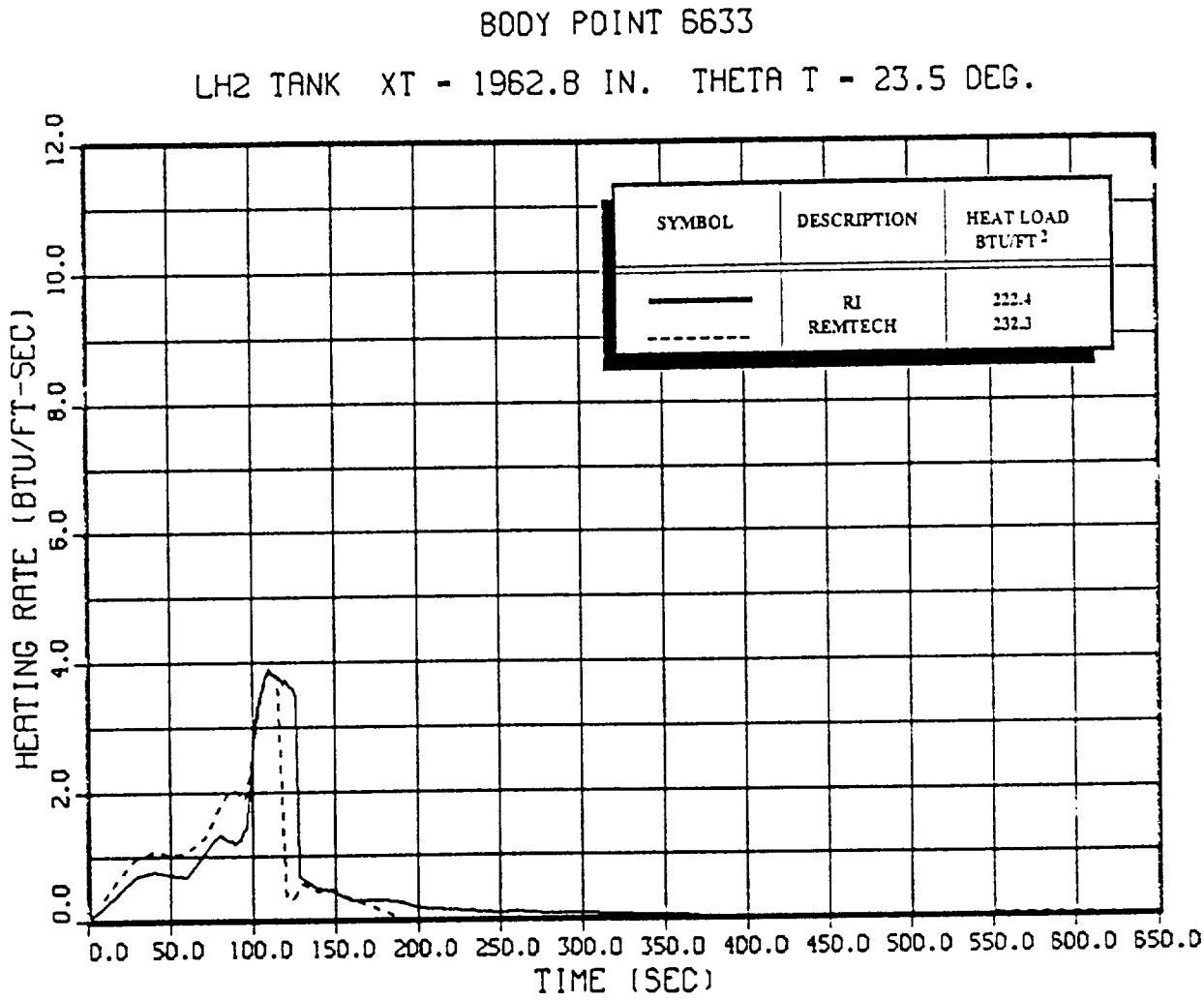
Agreement is acceptable; no TPS impact.

BODY POINT 6632

LH2 TANK XT = 1955.3 IN. THETA T = 23.5 DEG.



Agreement is acceptable; no TPS impact.



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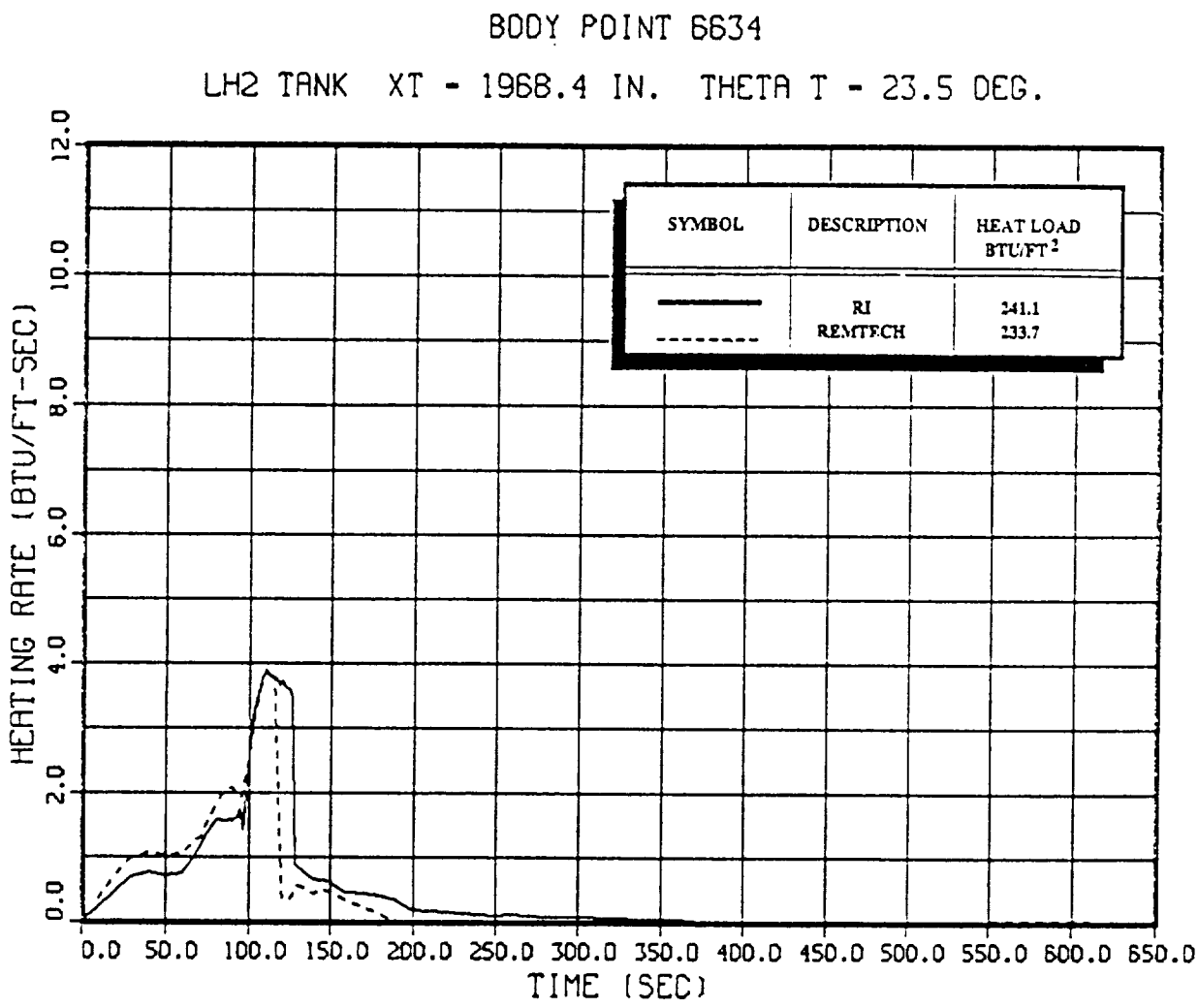
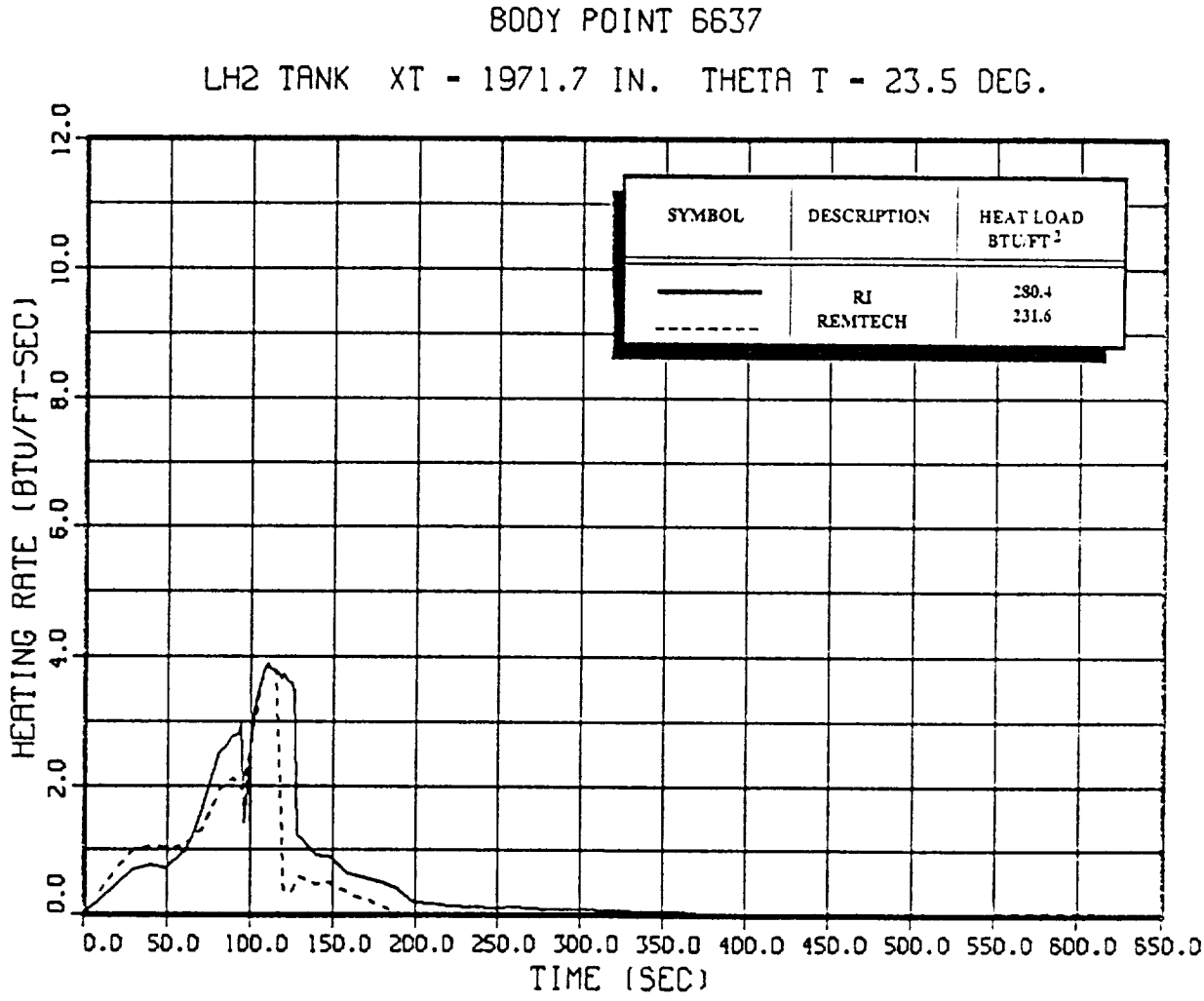


Agreement is acceptable; no TPS impact.



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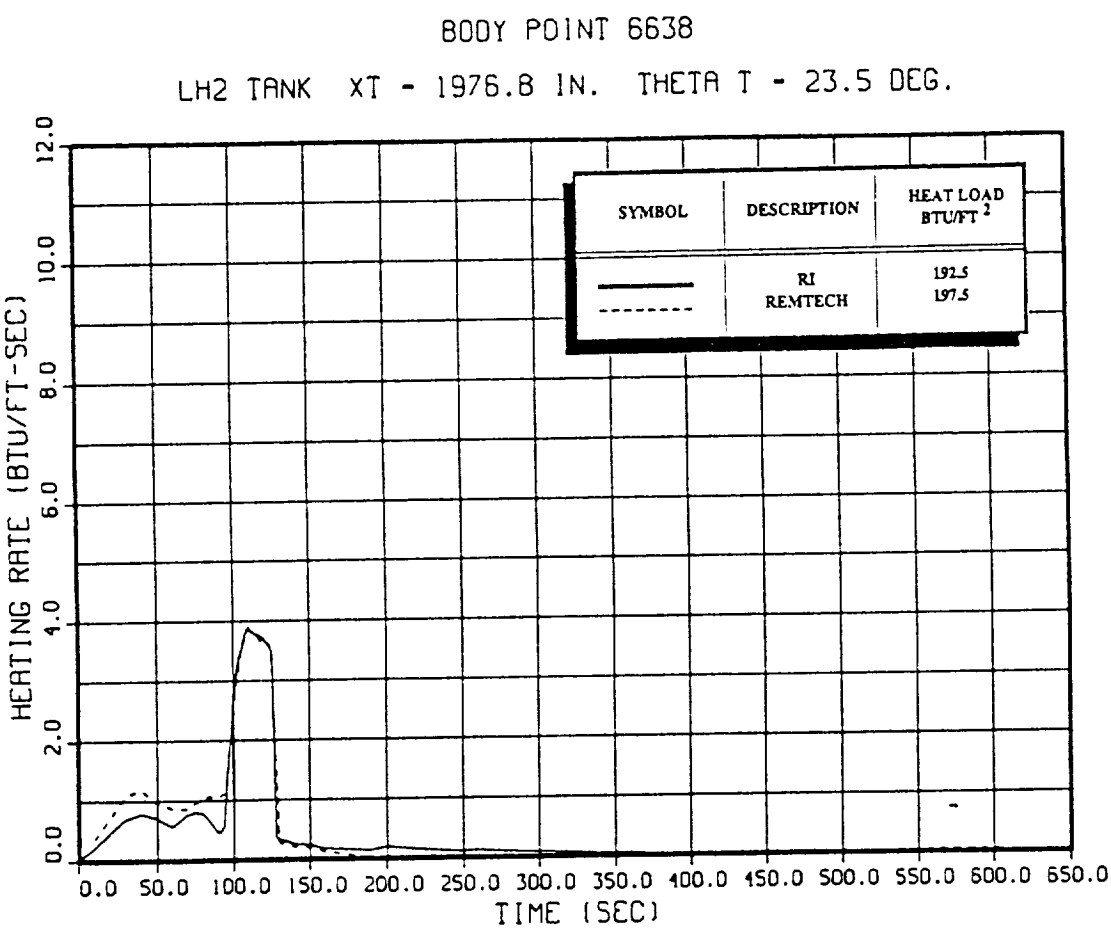
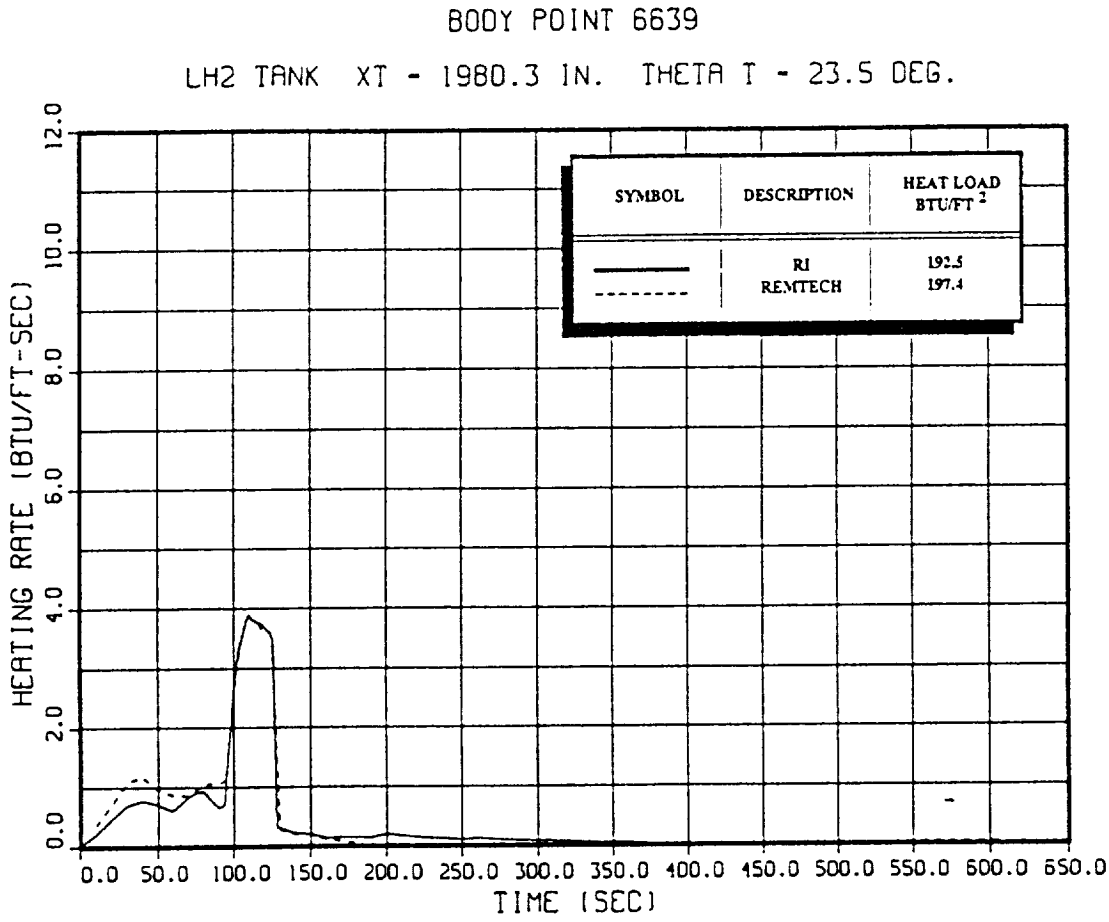
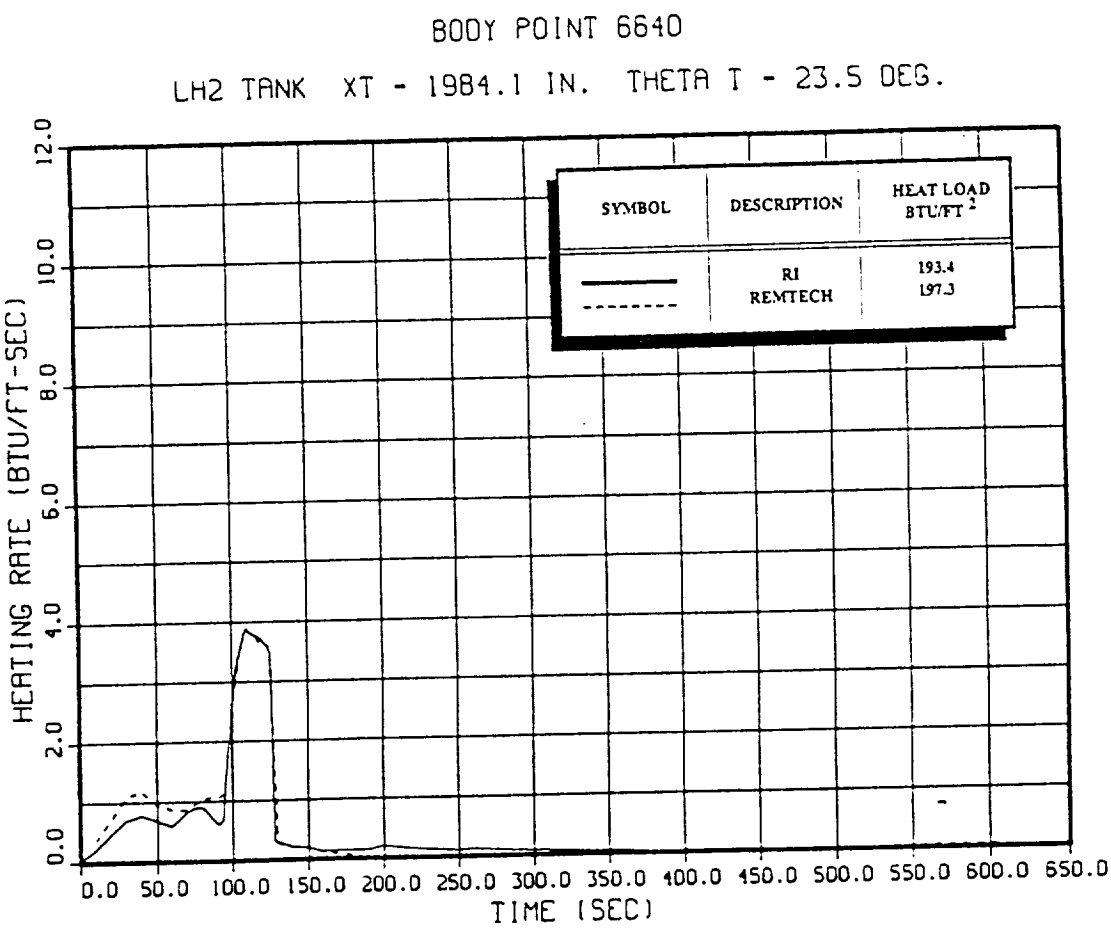


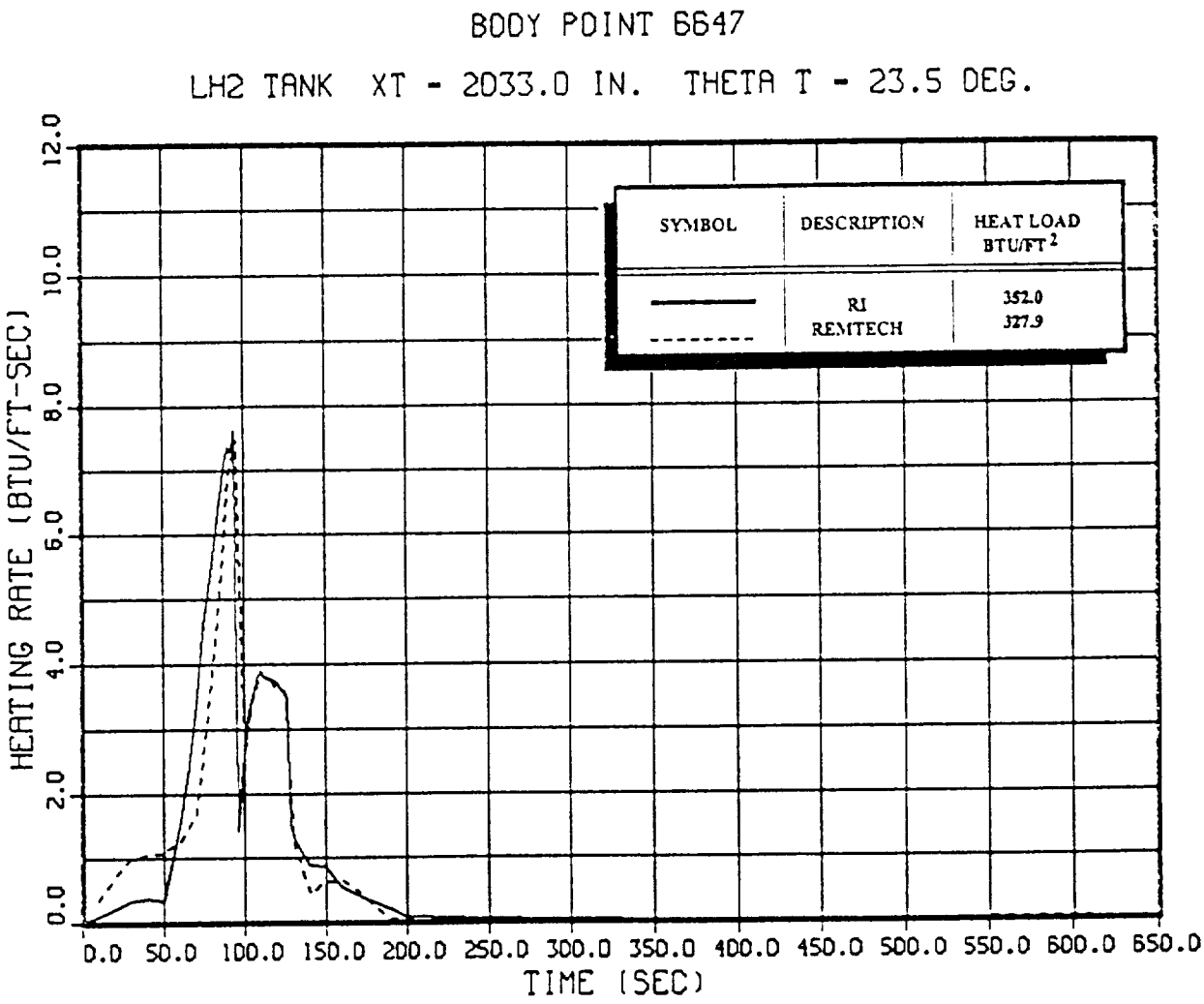
Agreement is acceptable; no TPS impact.



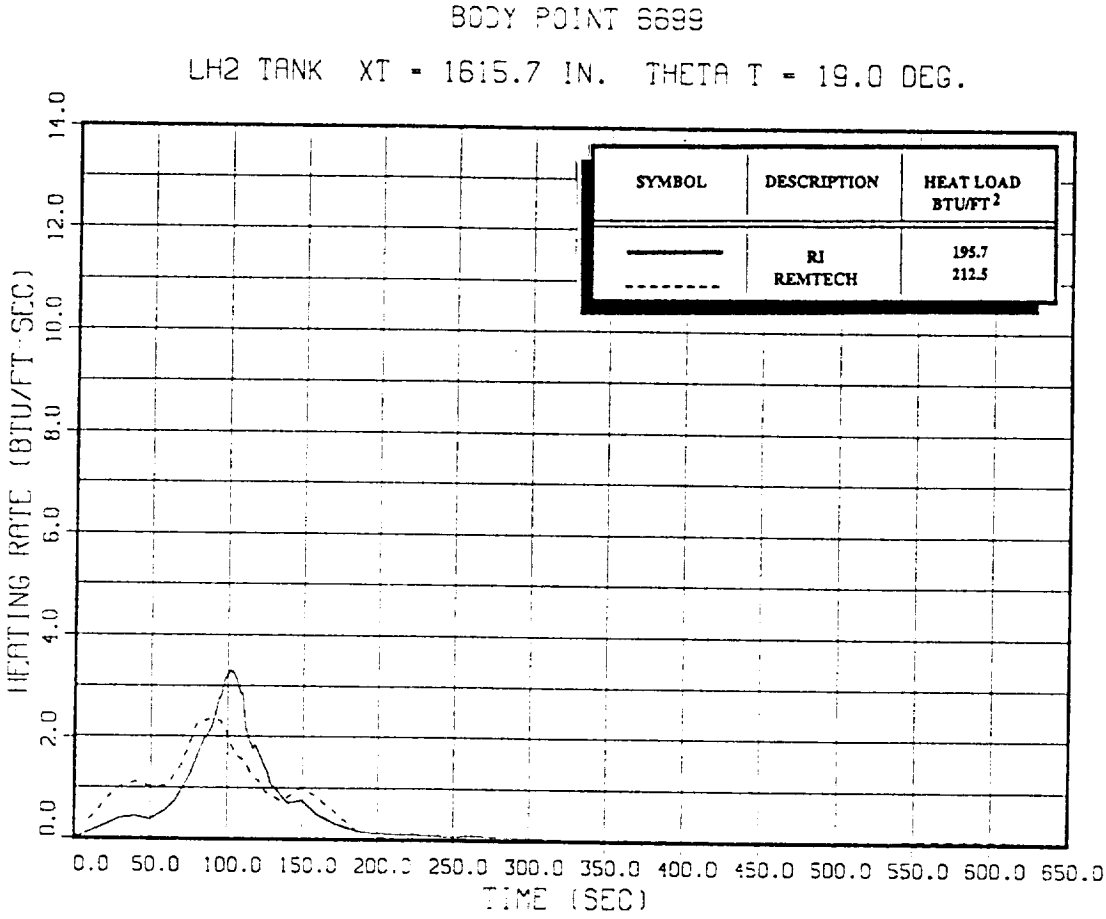
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



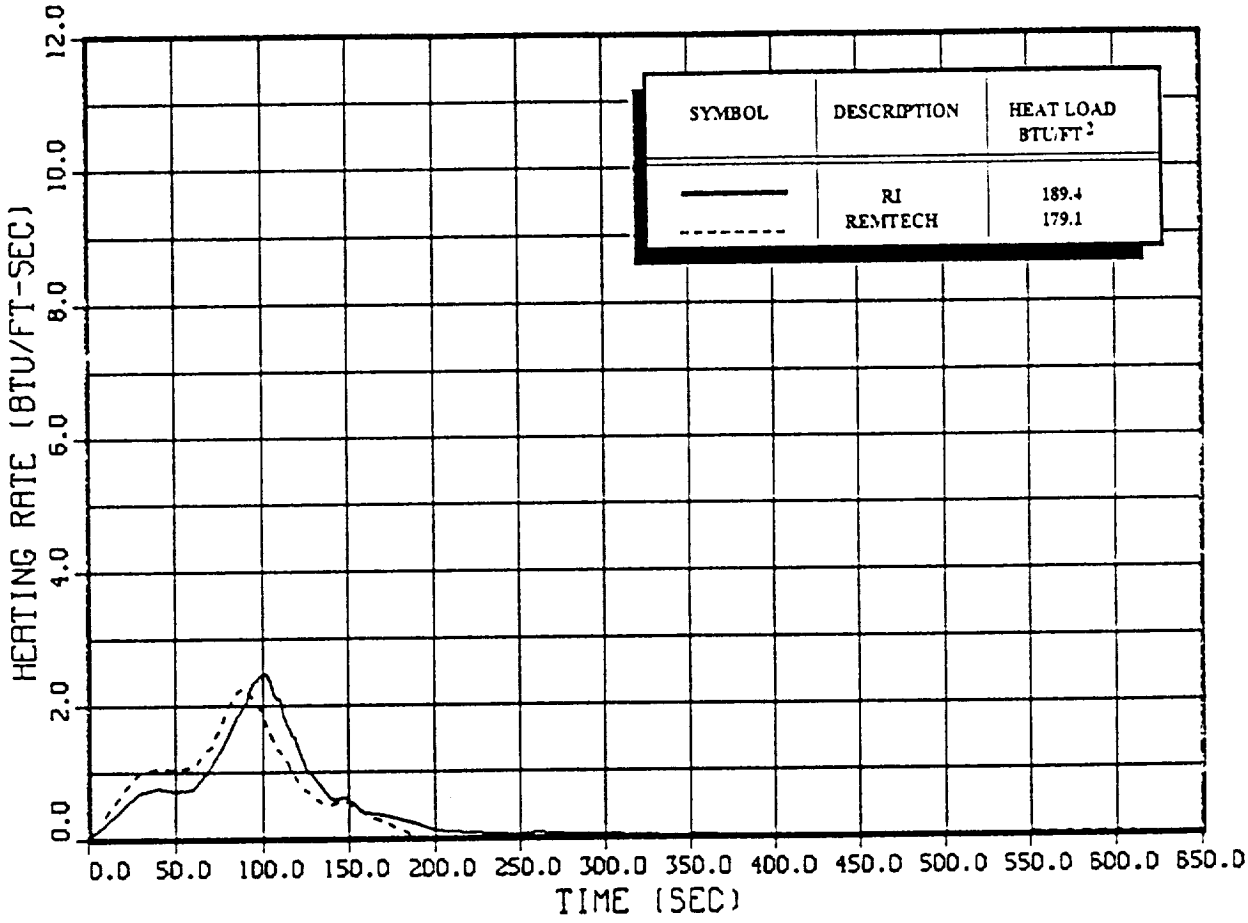
Agreement is acceptable; no TPS impact.



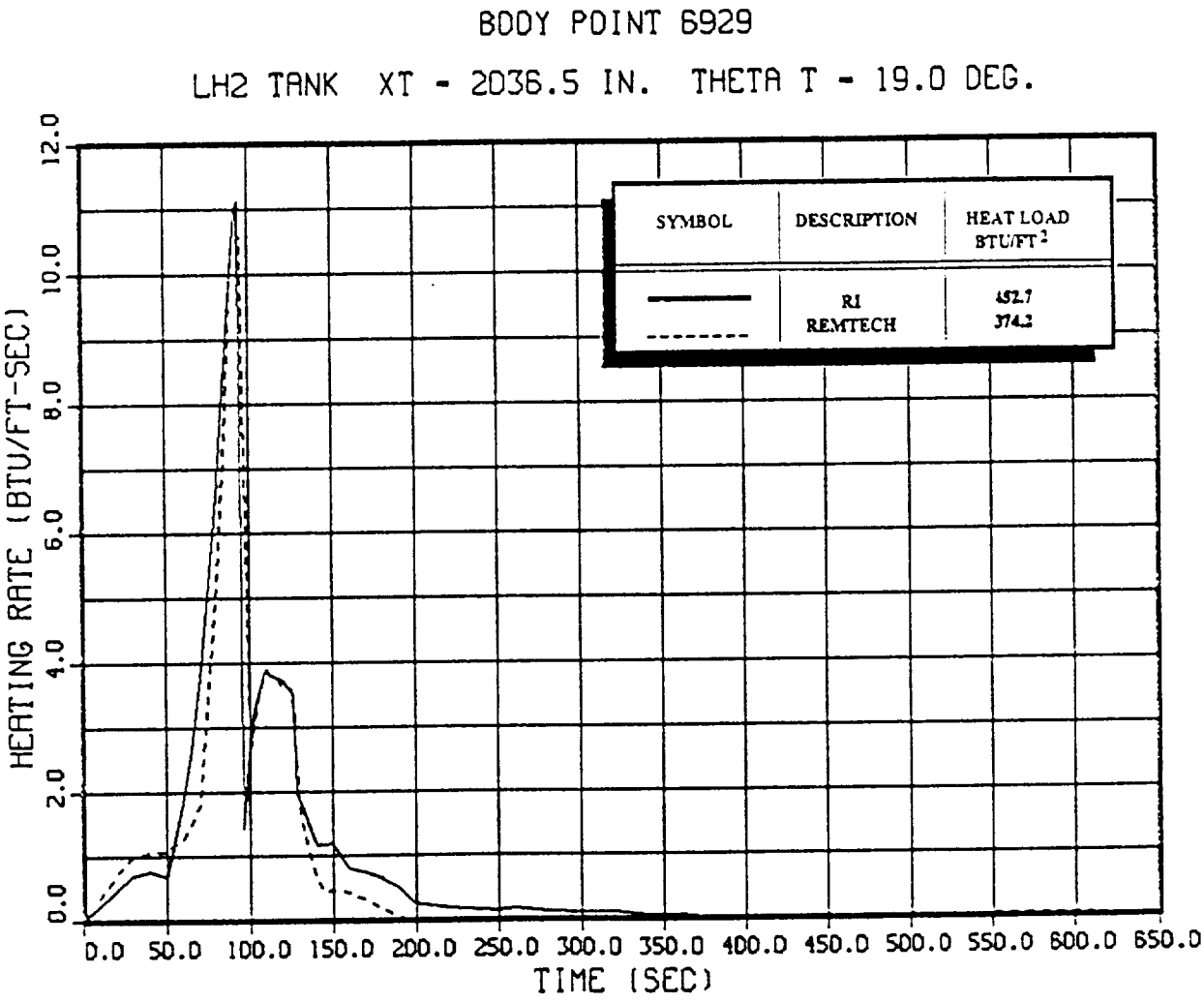
Agreement is acceptable; no TPS impact.

BODY POINT 6909

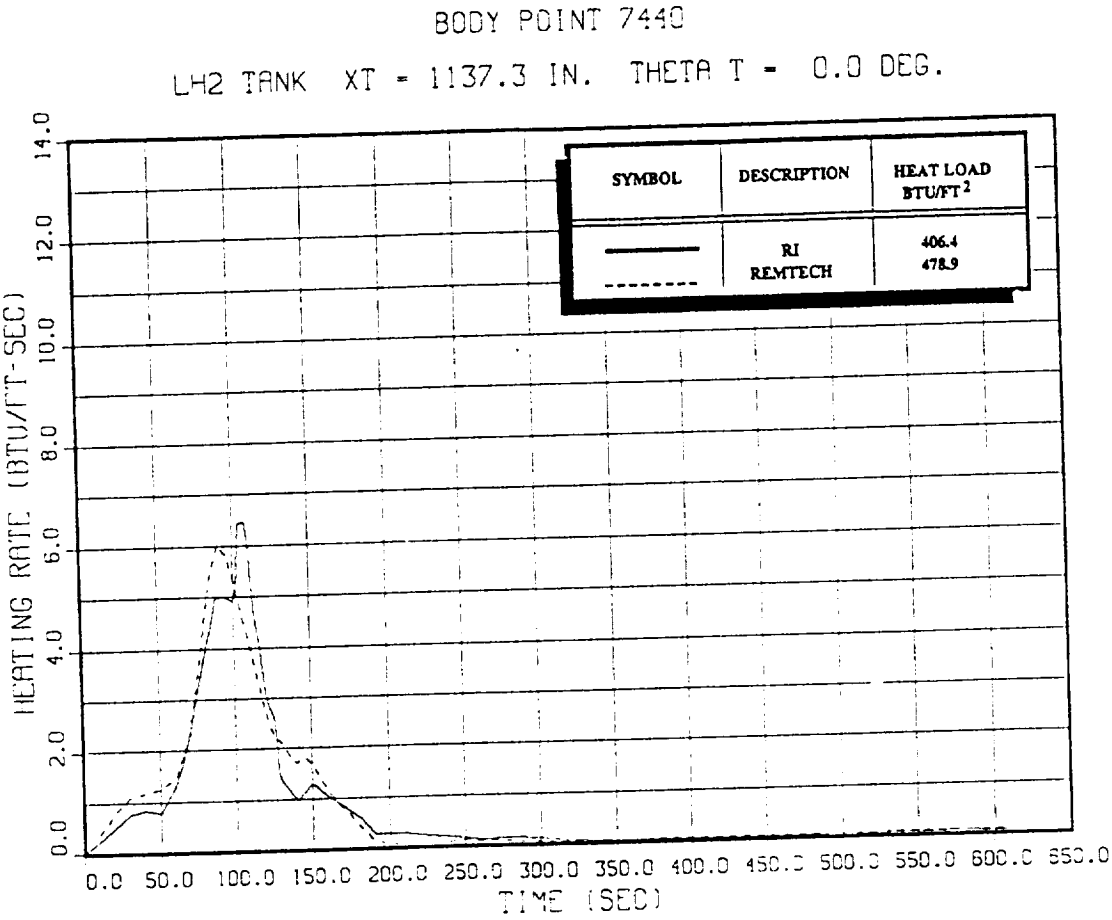
LH2 TANK XT - 1999.5 IN. THETA T - 19.0 DEG.



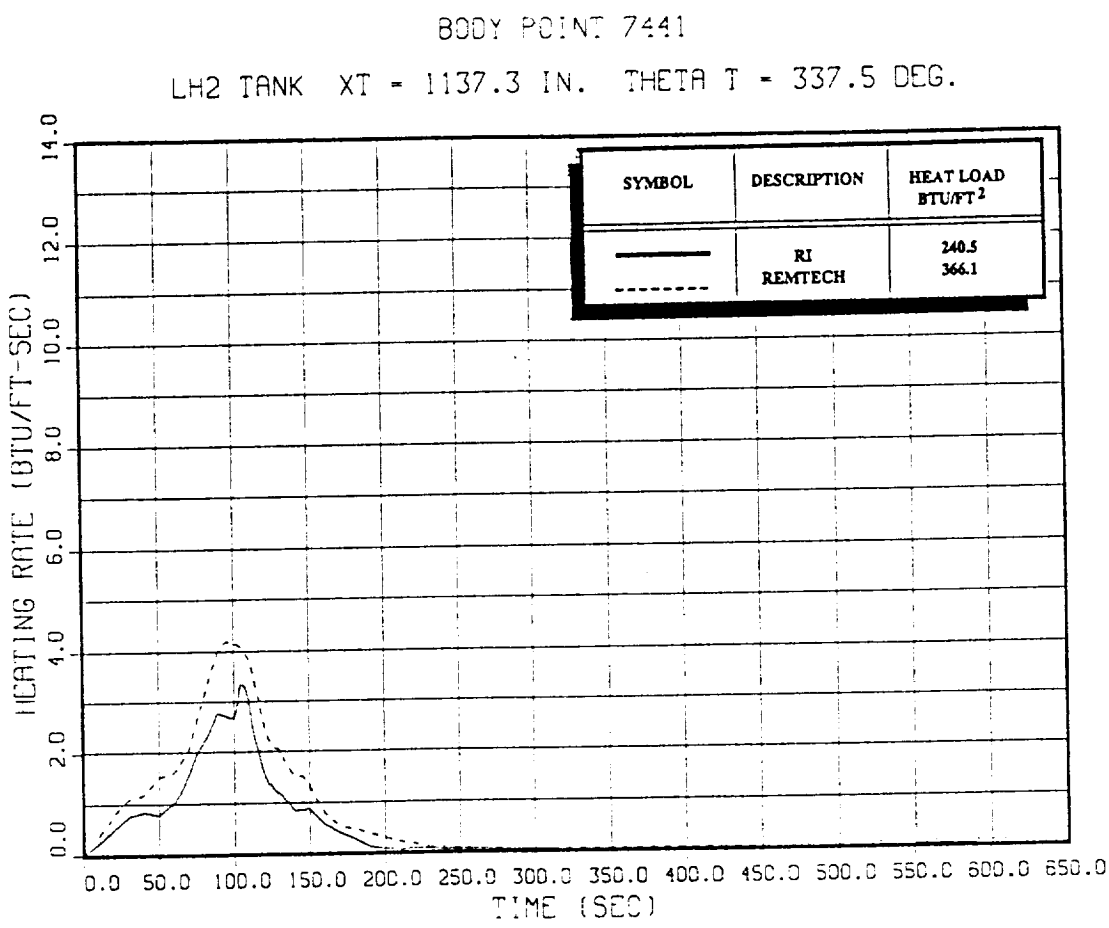
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



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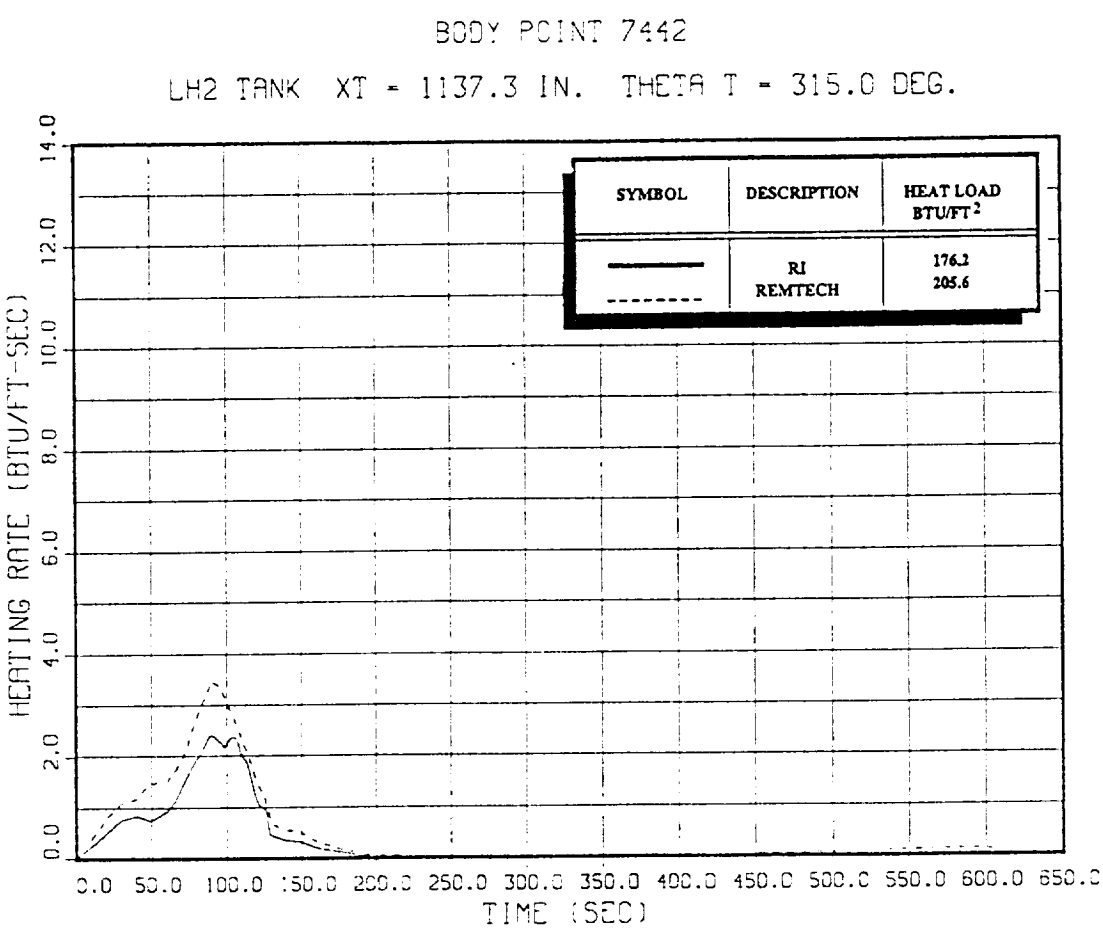
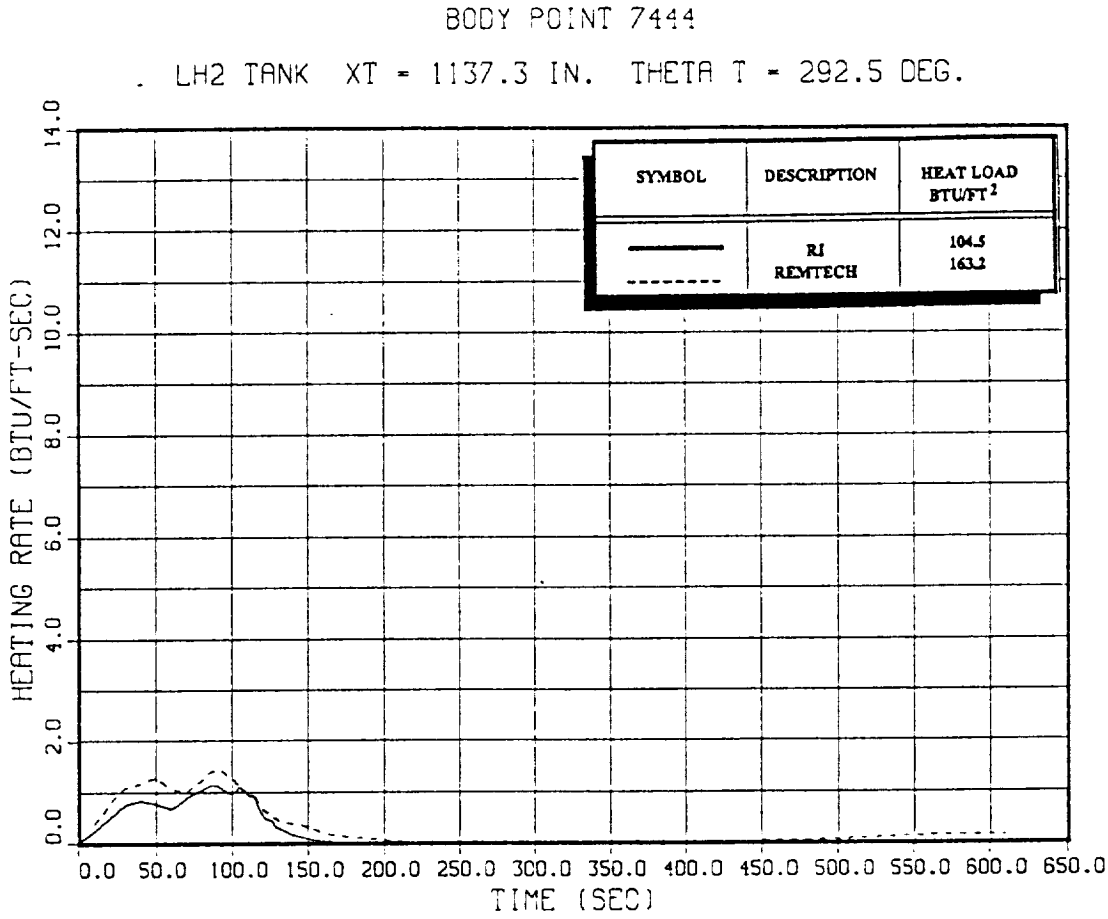
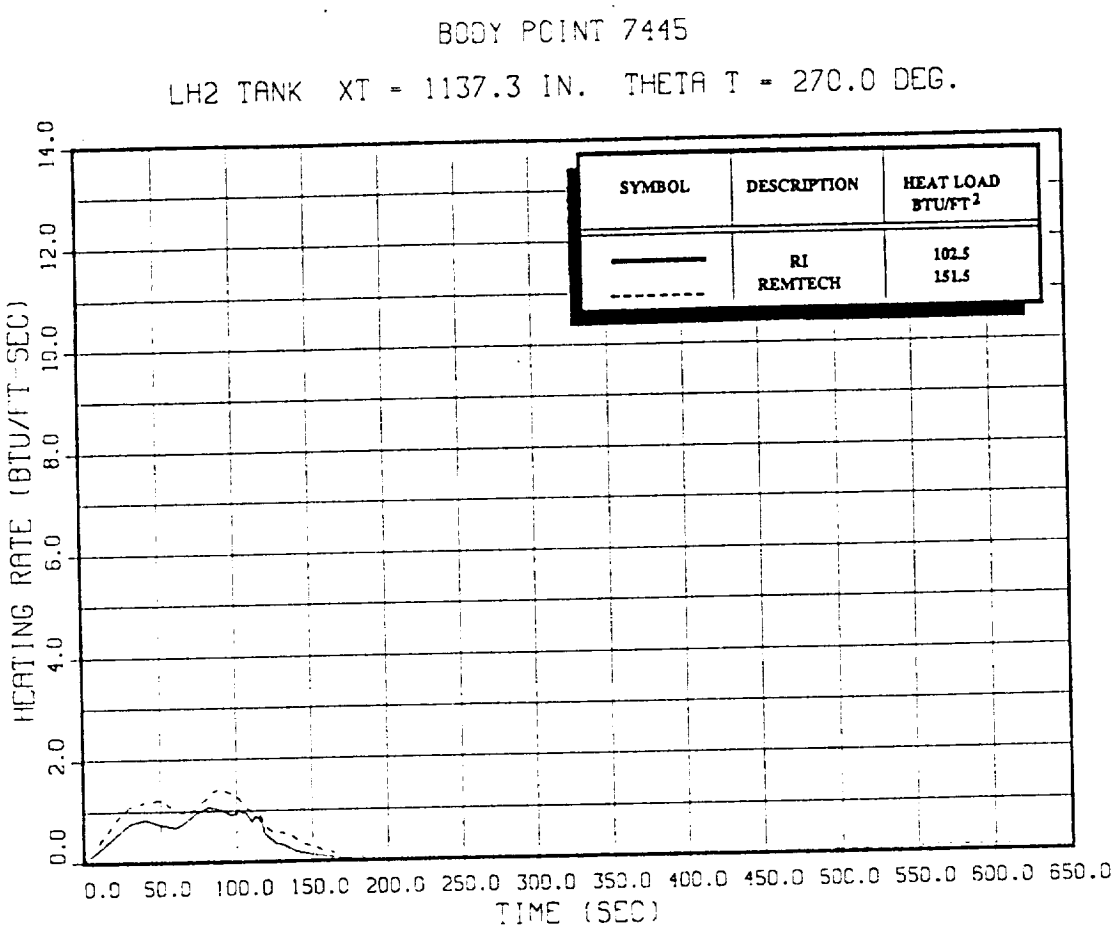


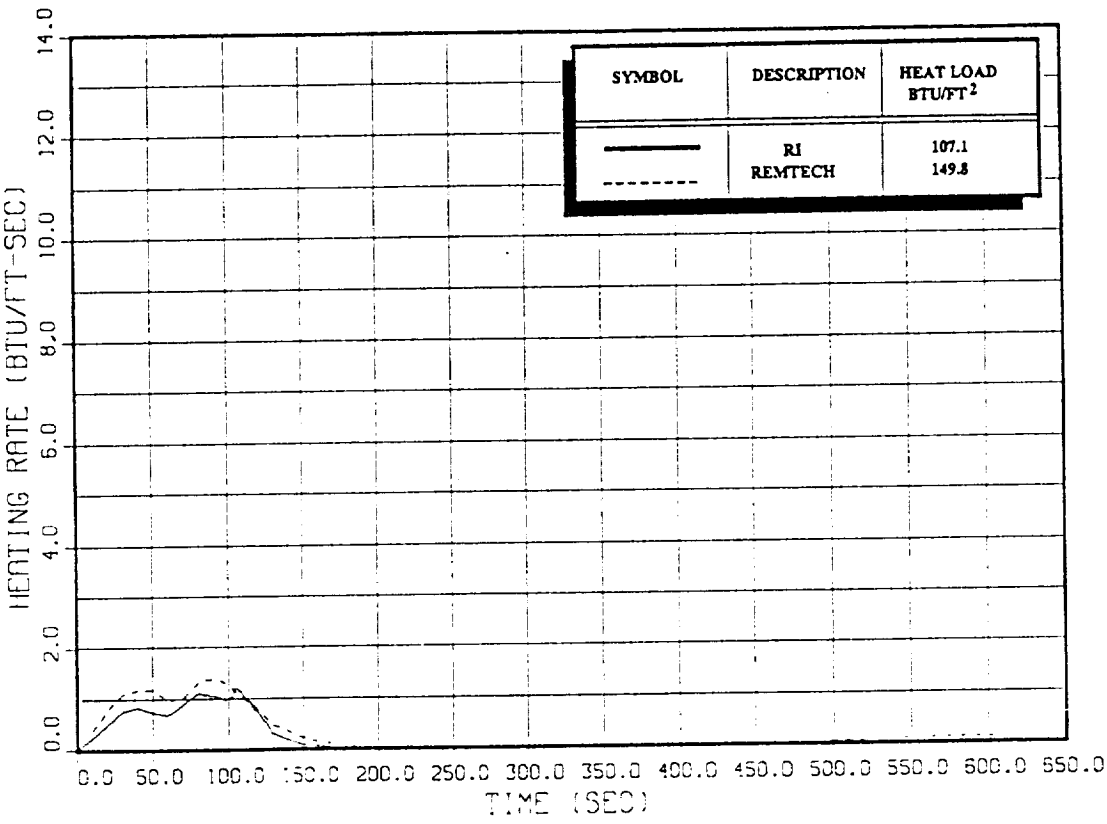
Agreement is acceptable; no TPS impact.



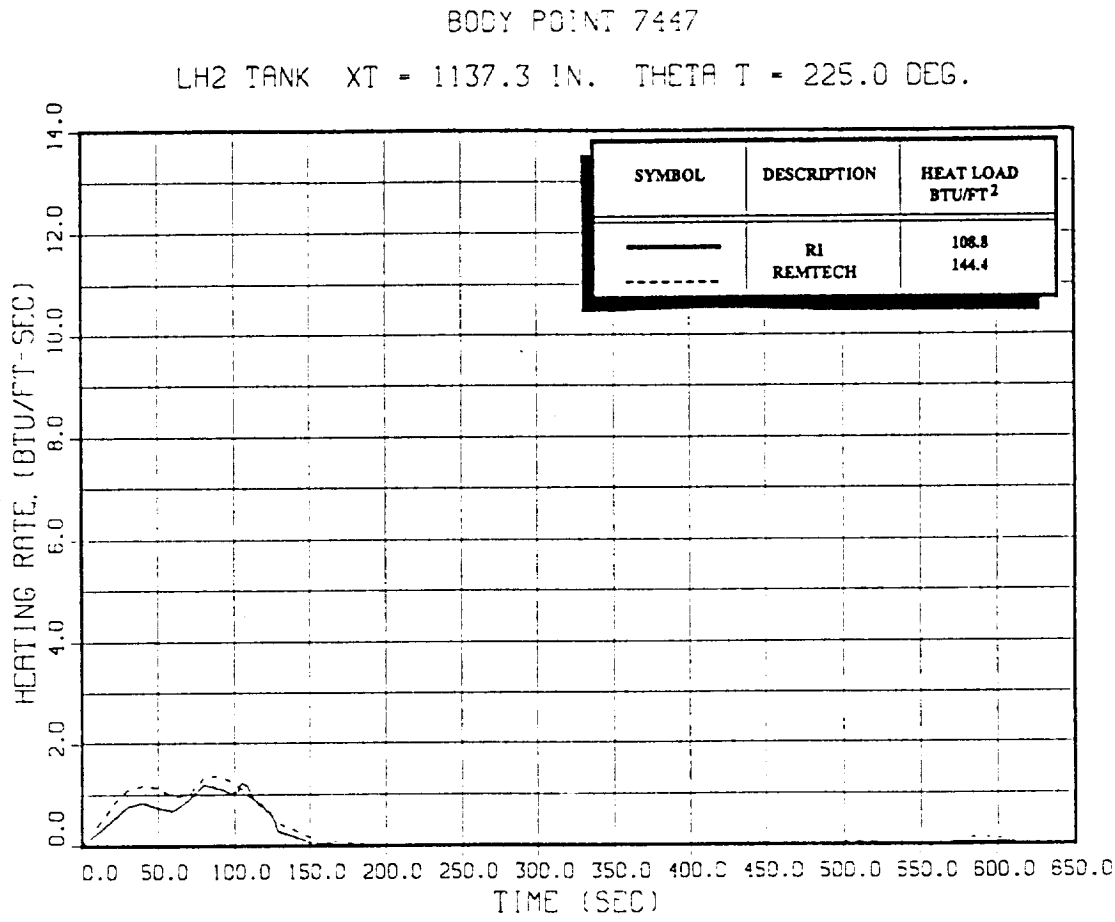
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



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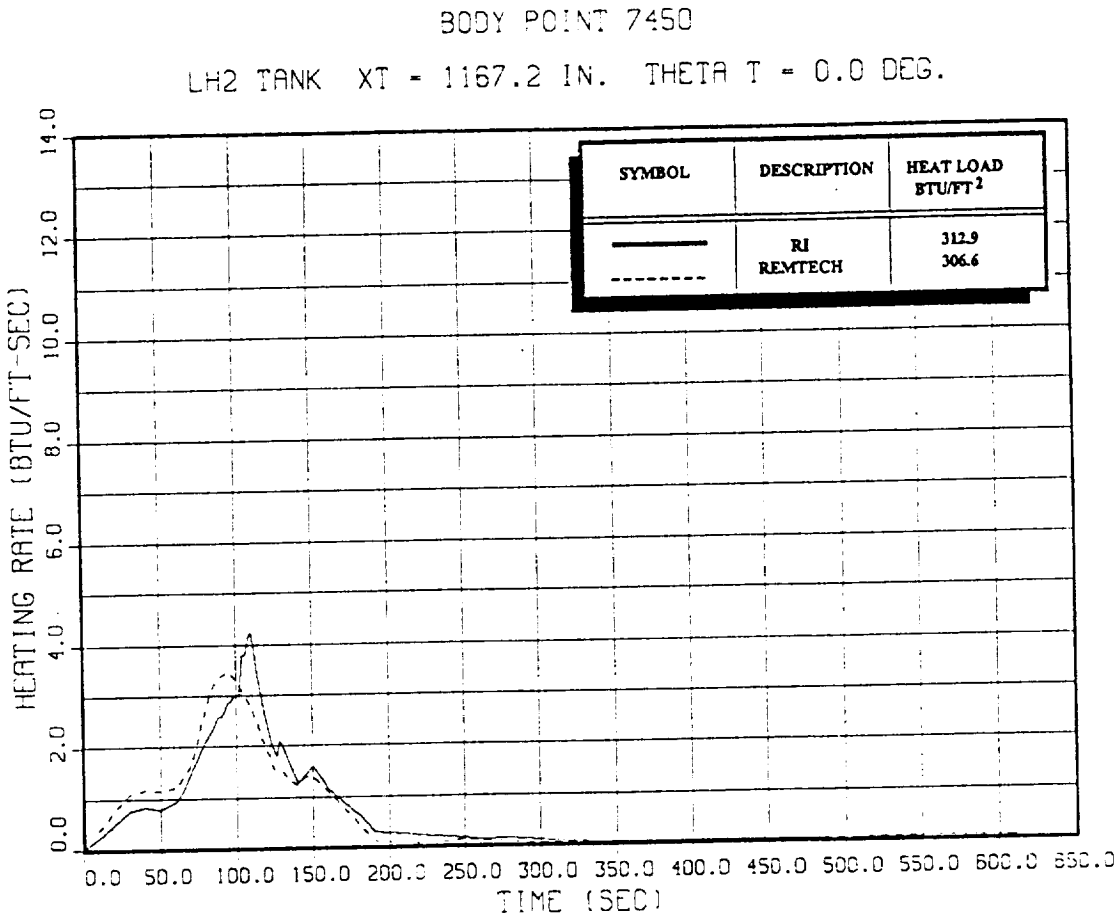

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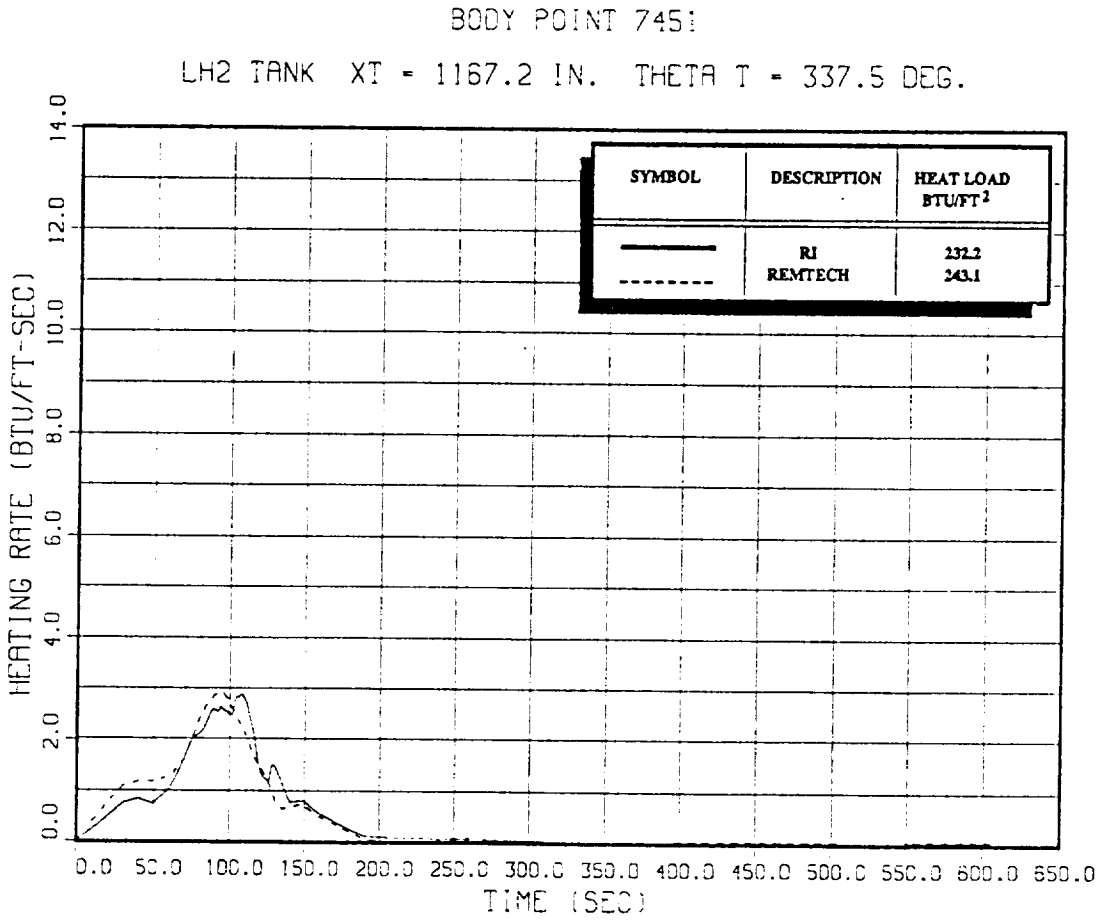

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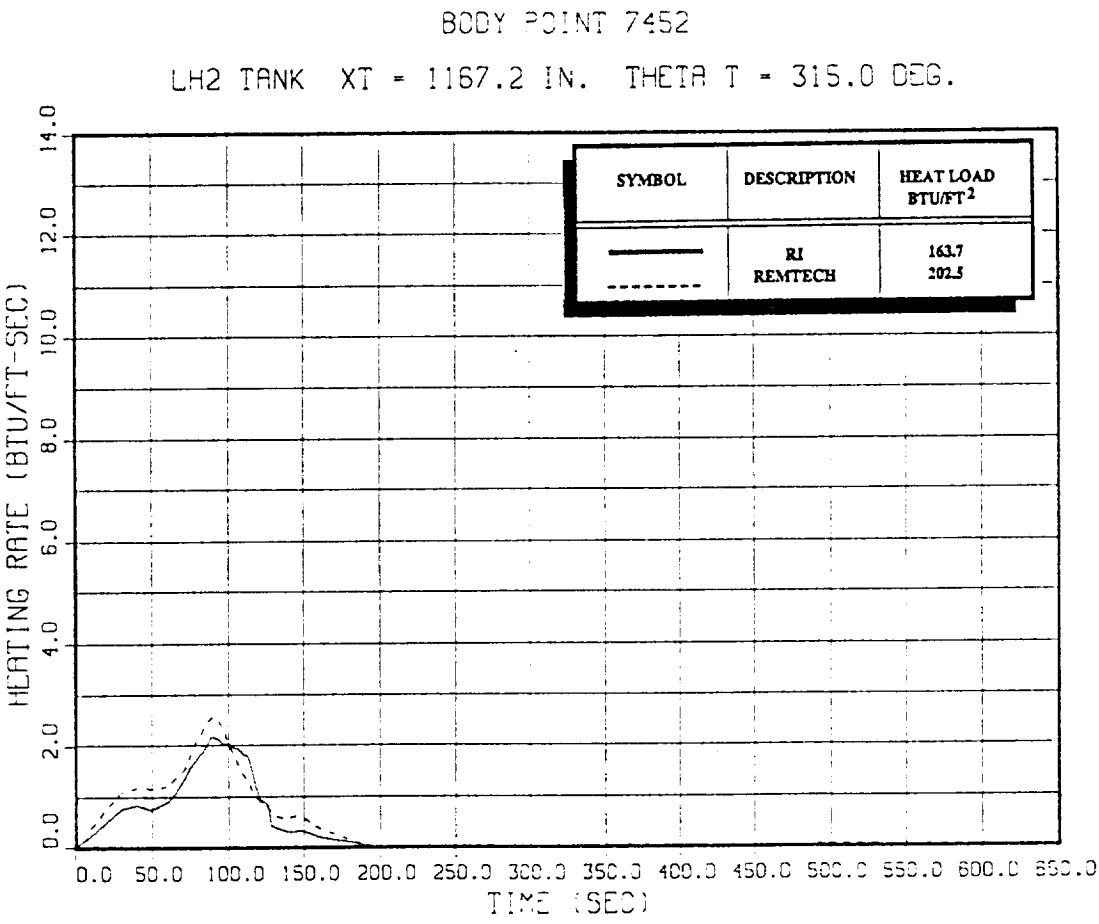

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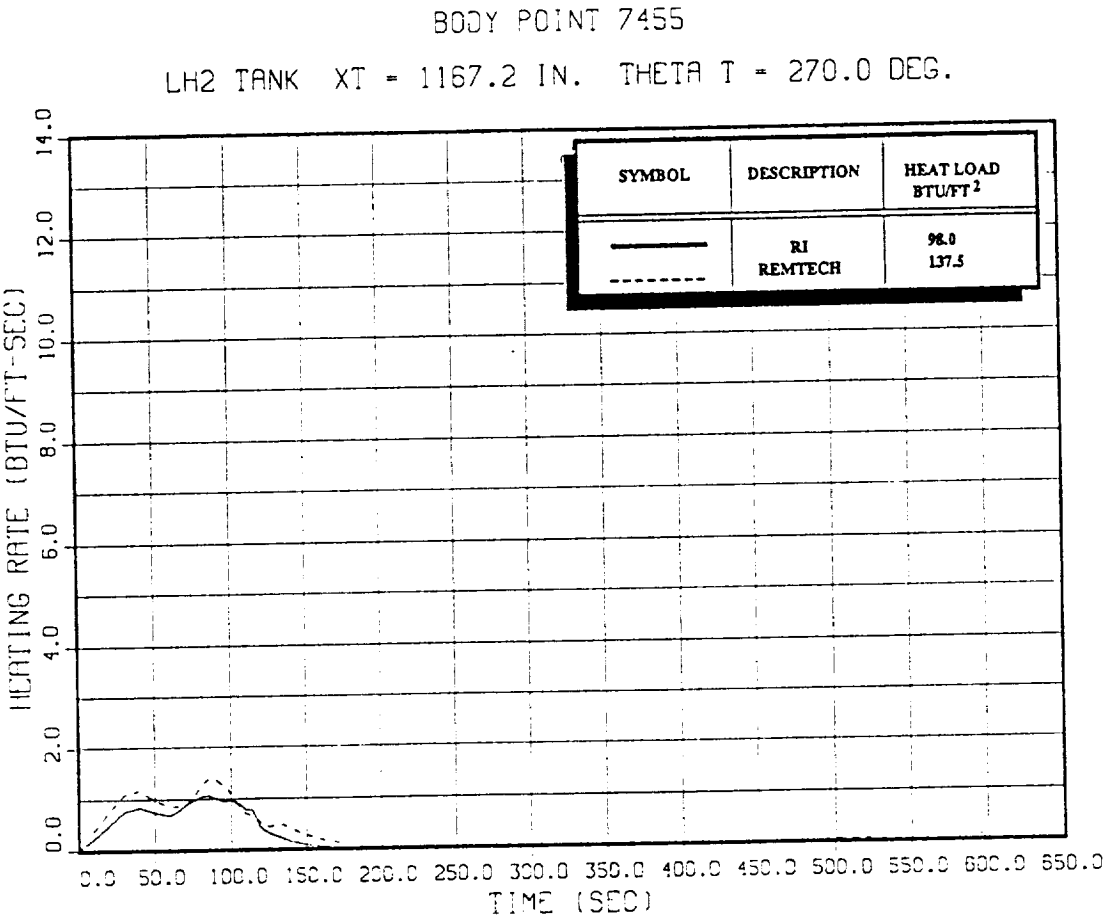

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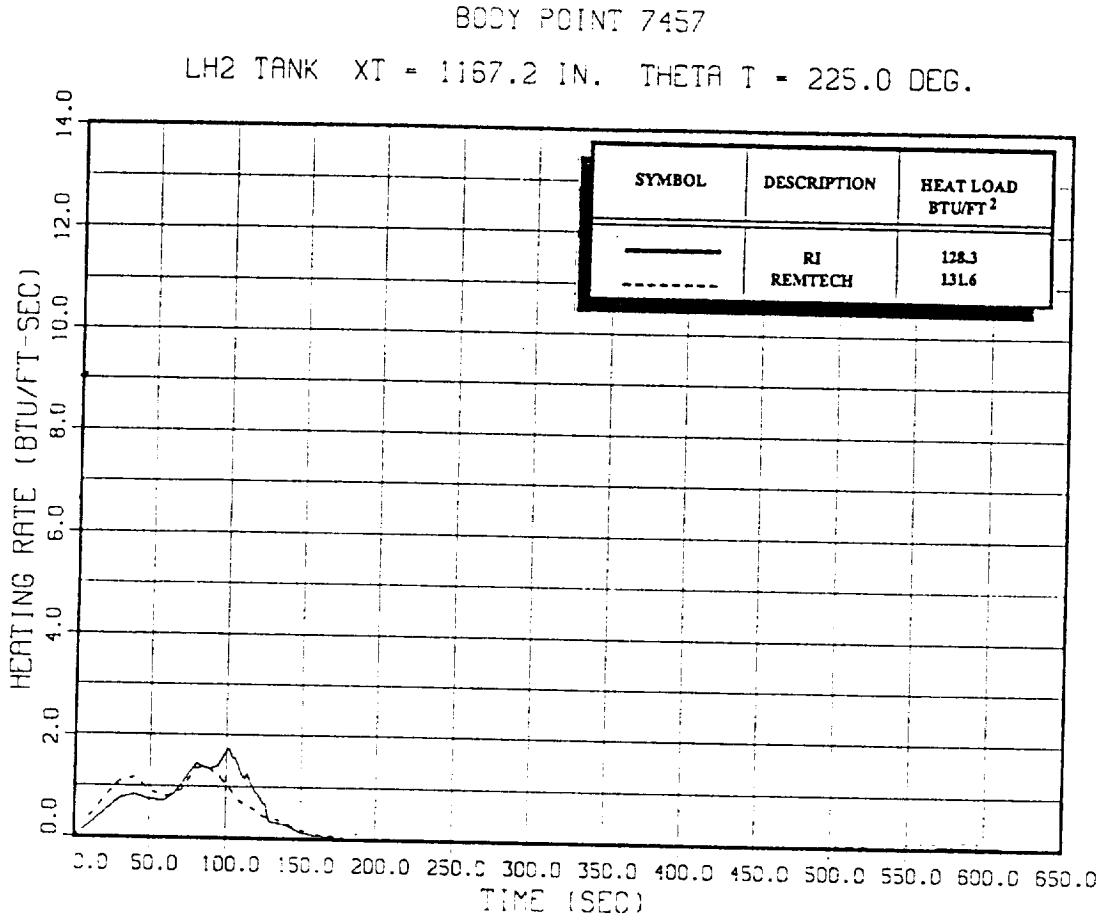

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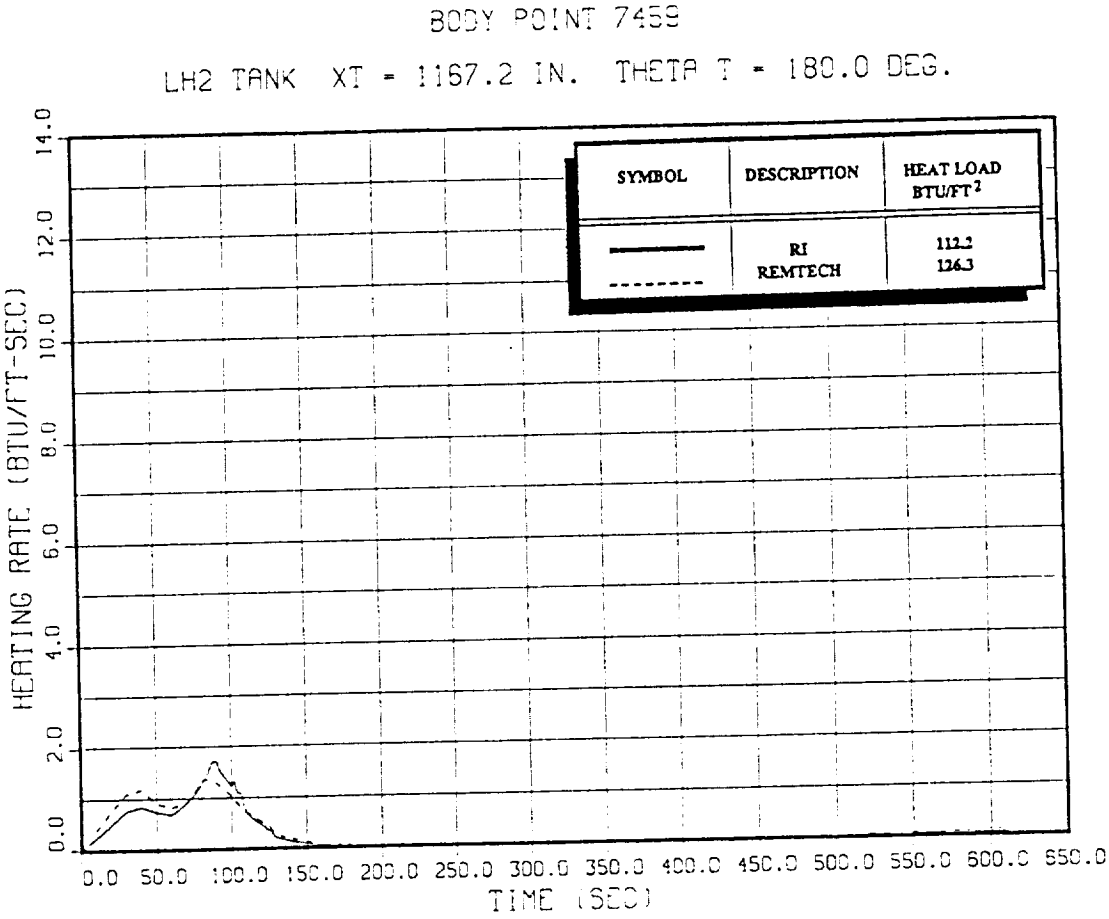

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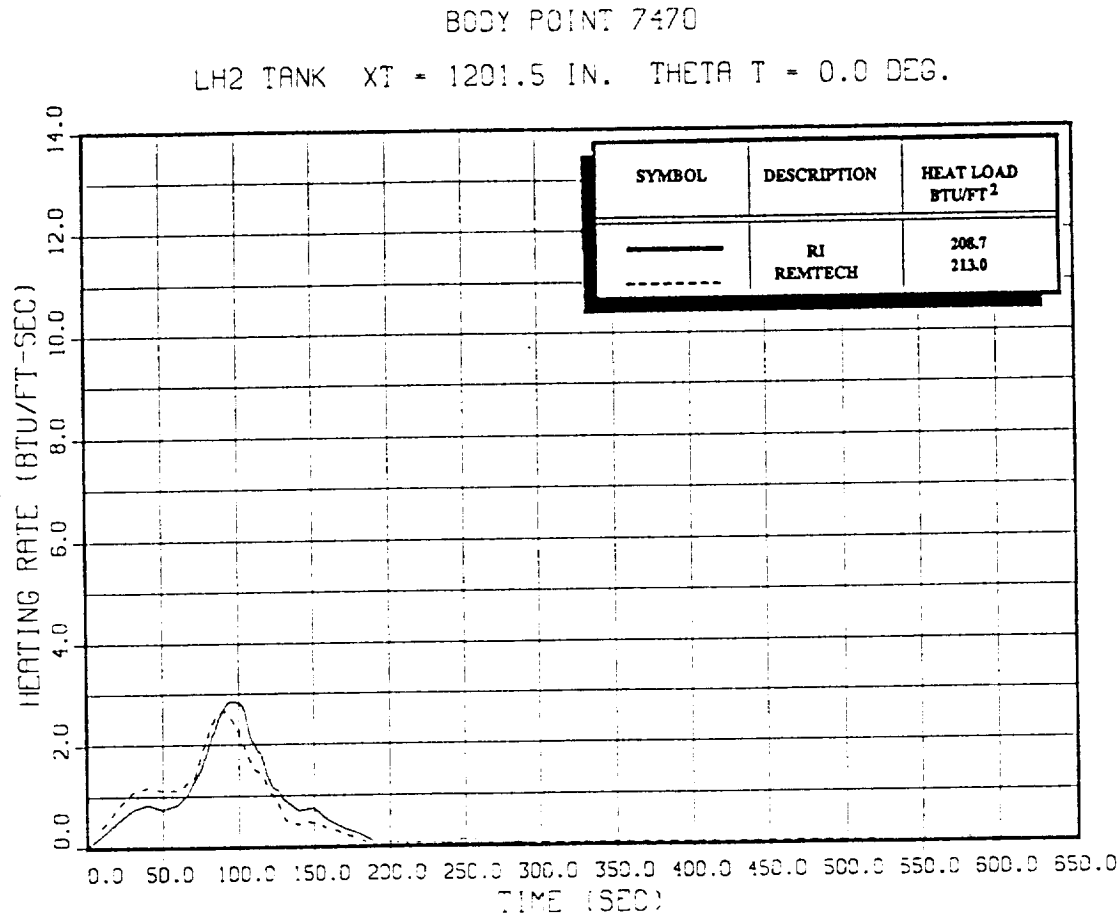

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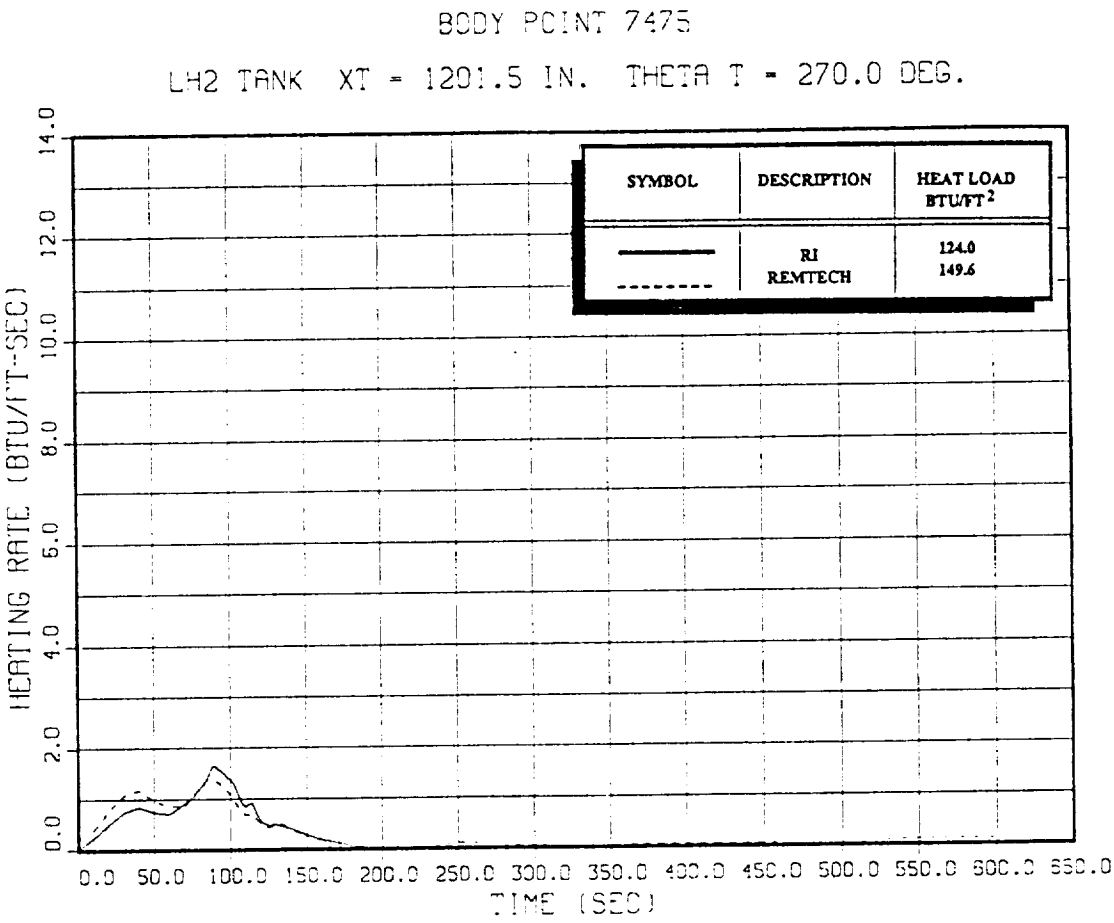

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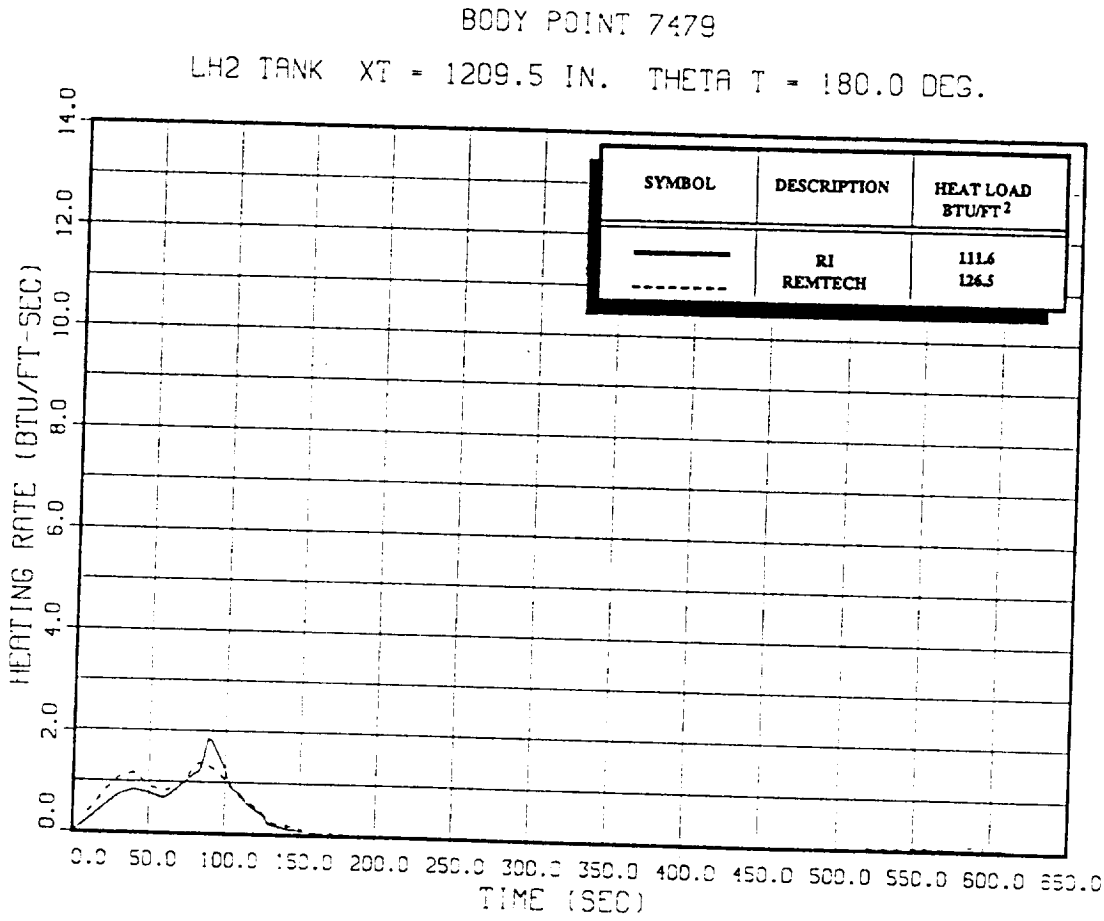

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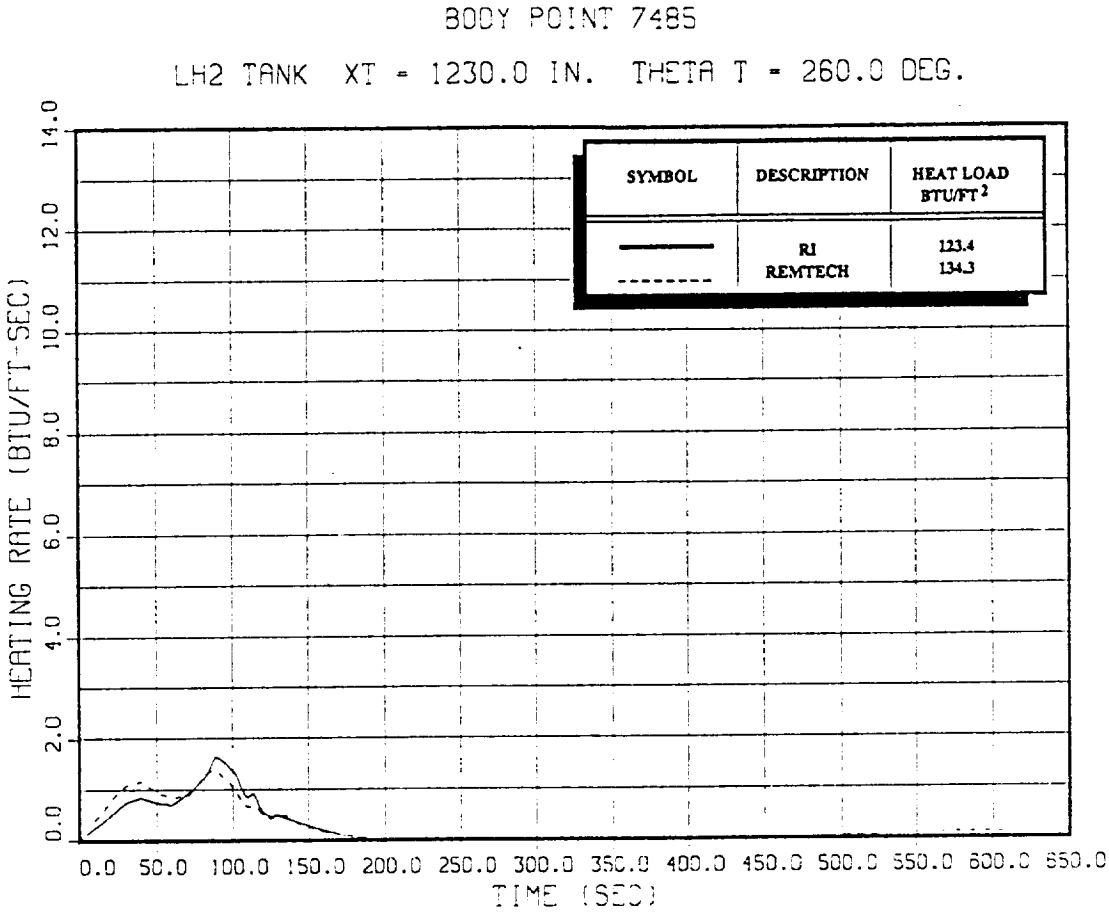
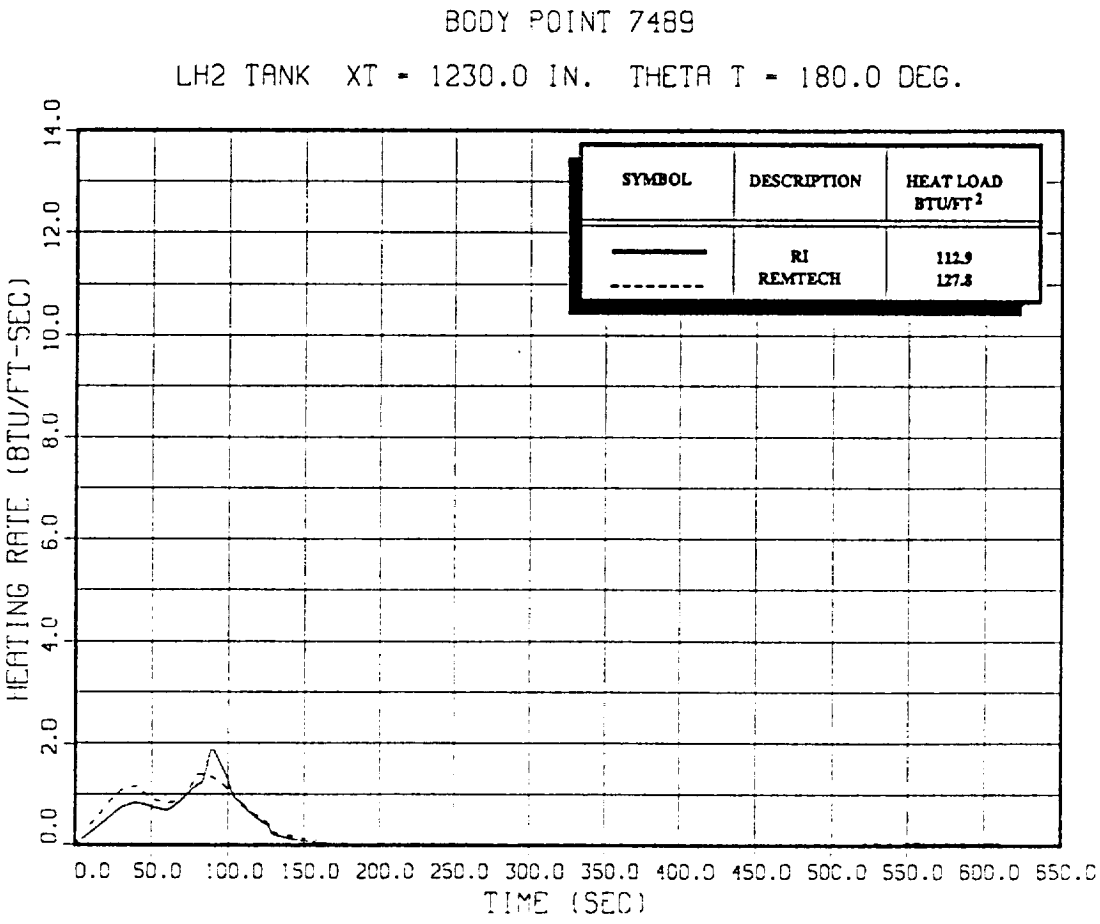
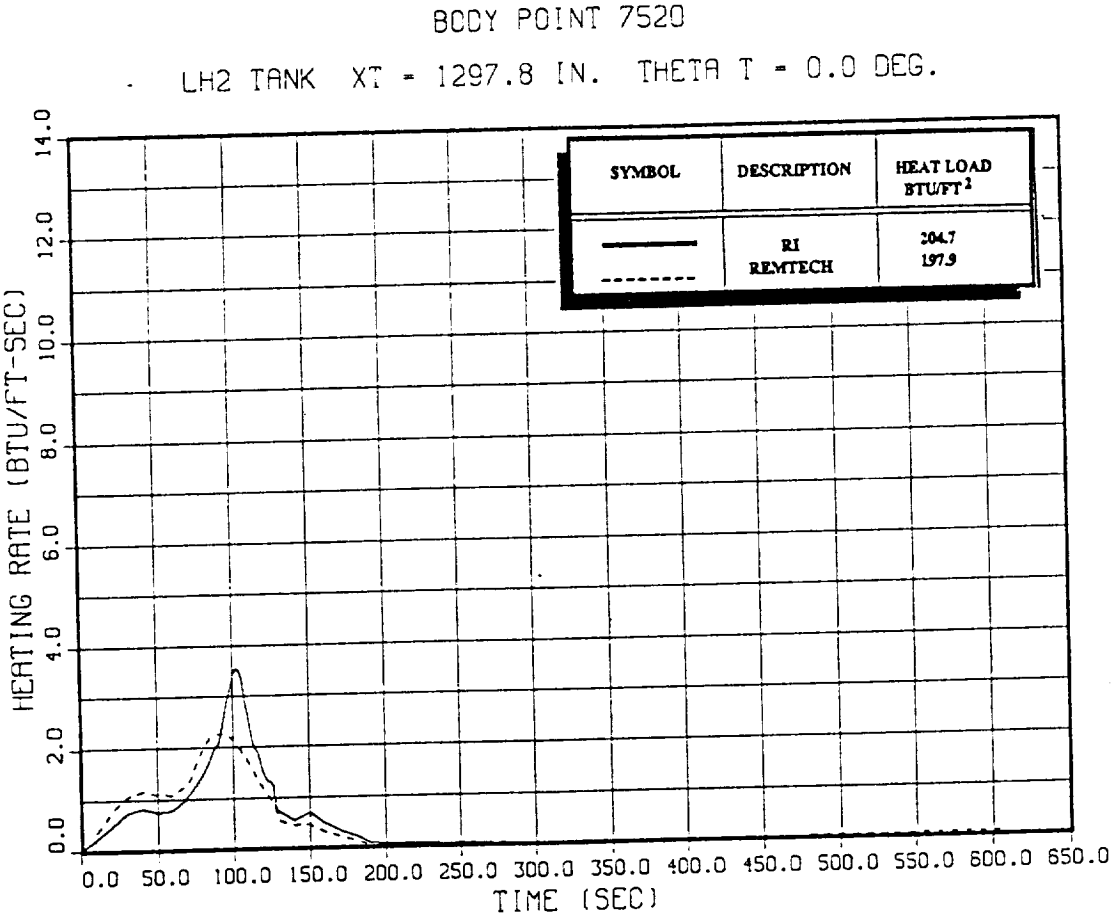


Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



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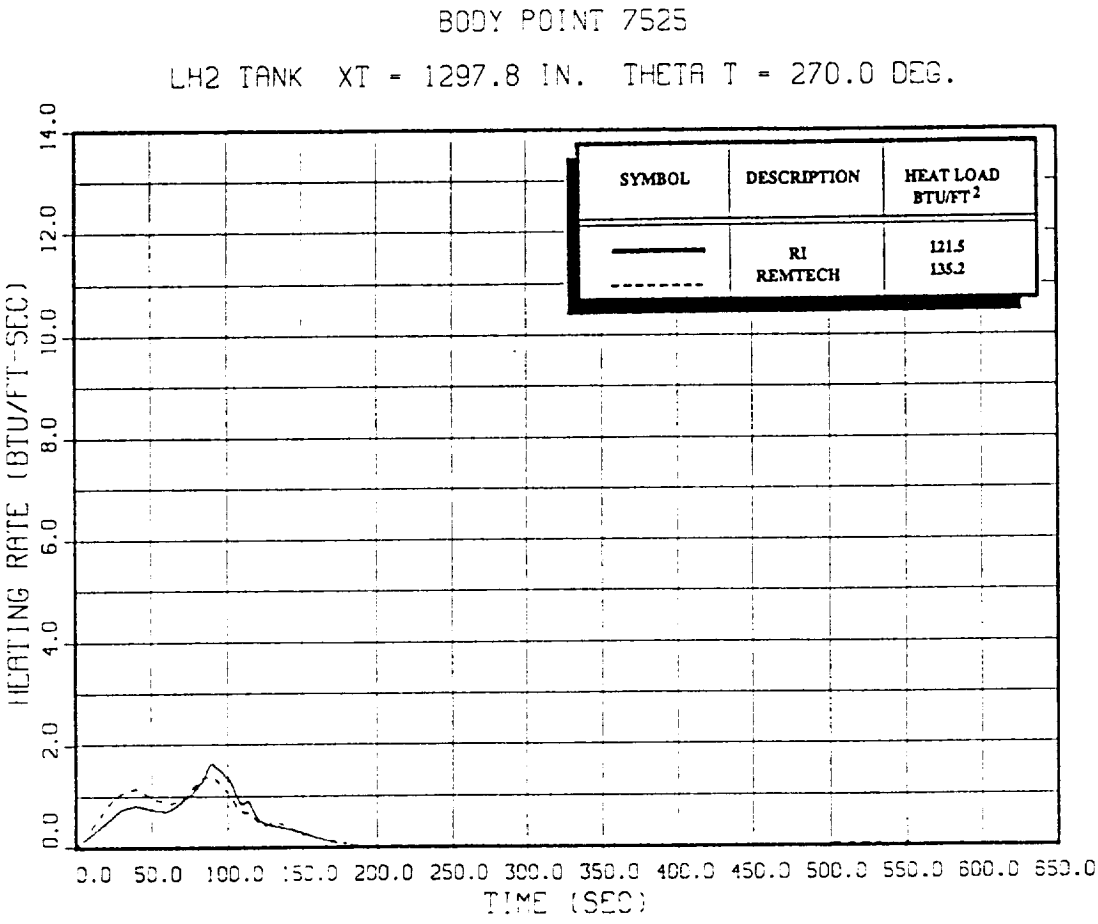

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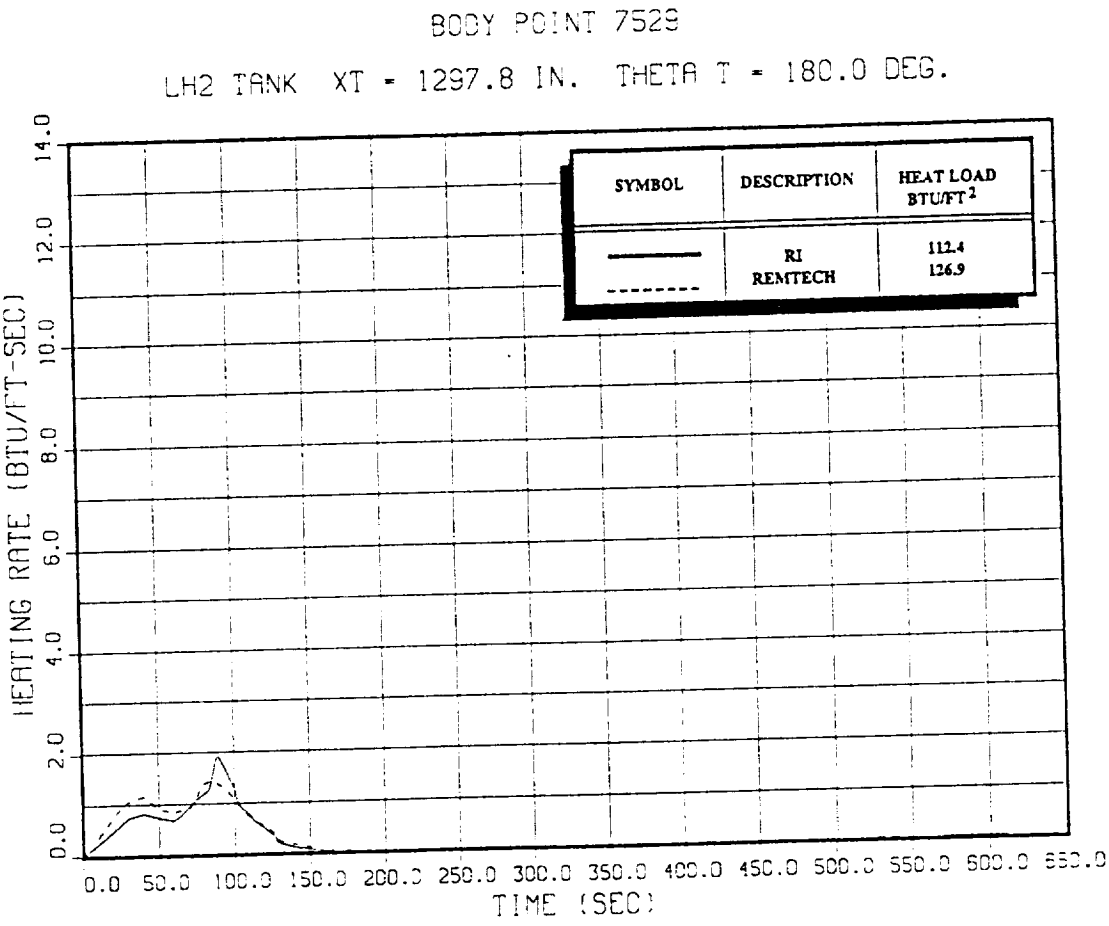

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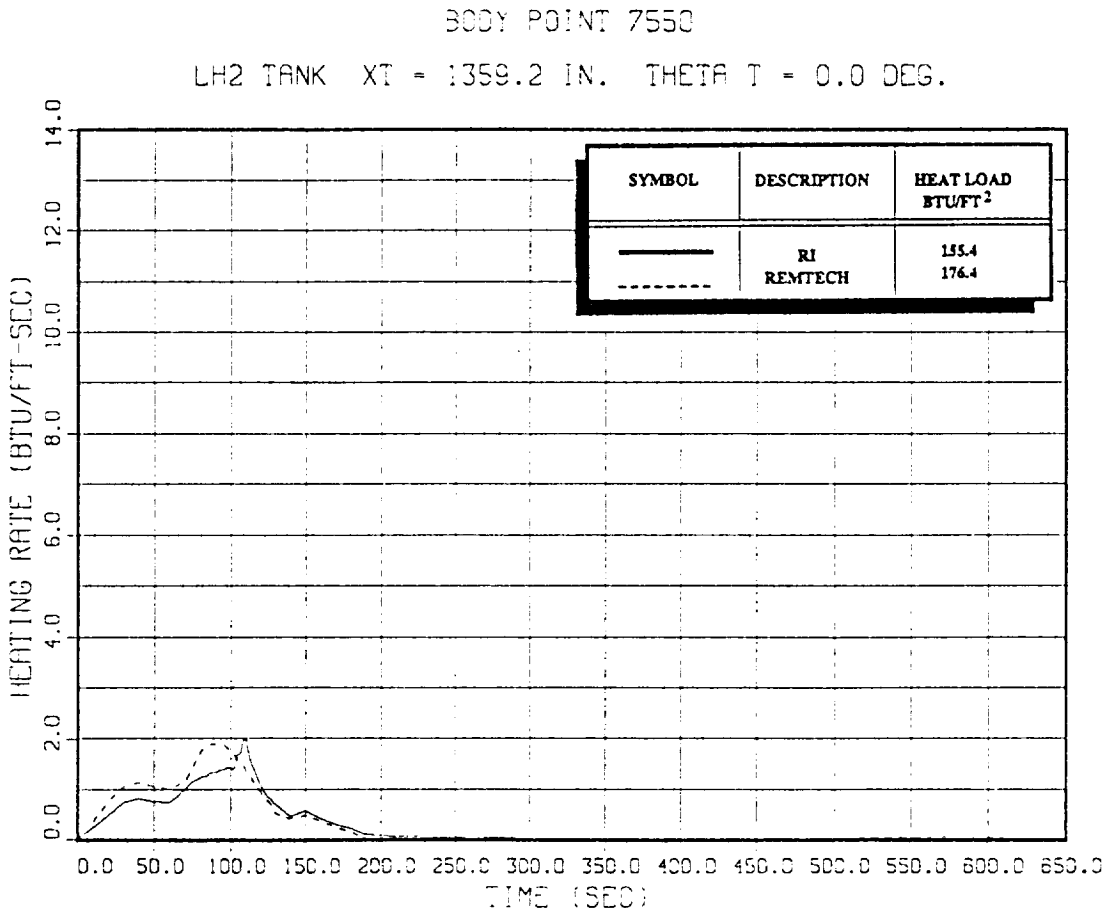

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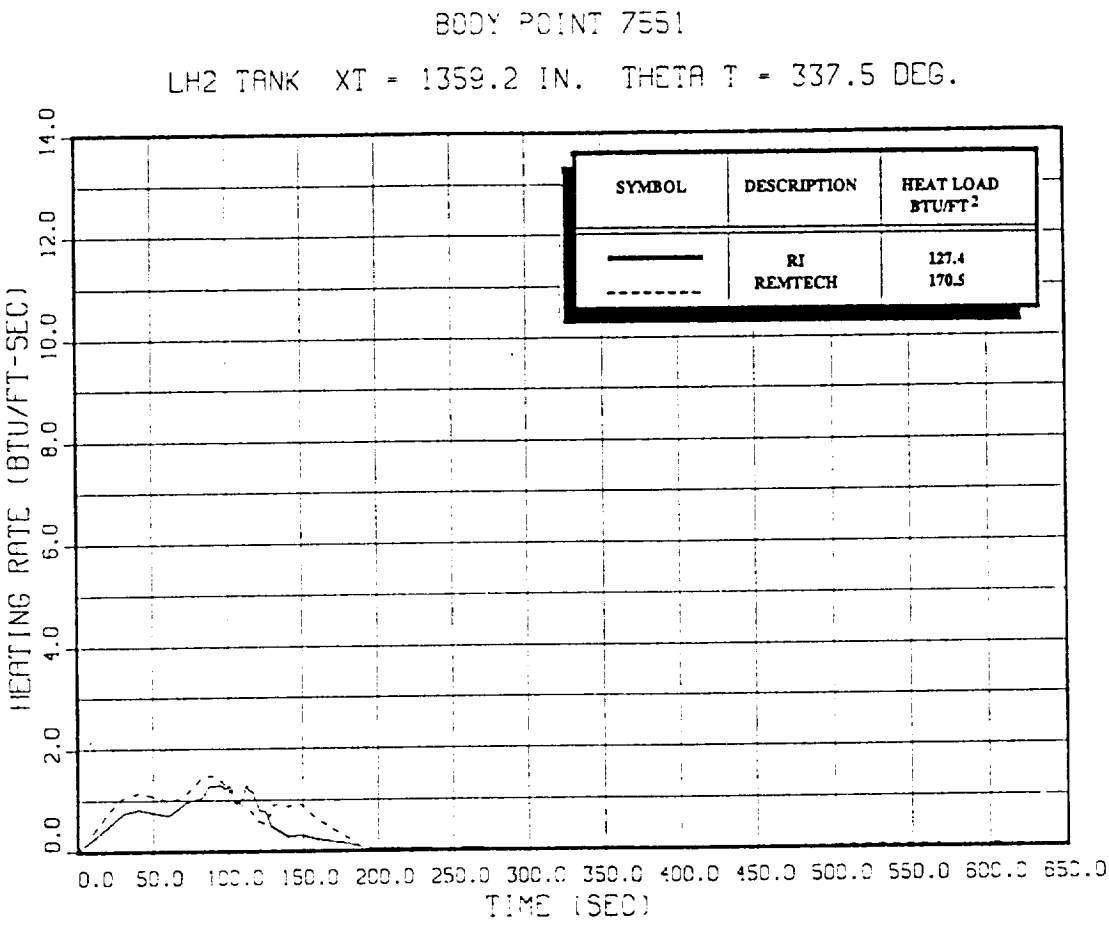

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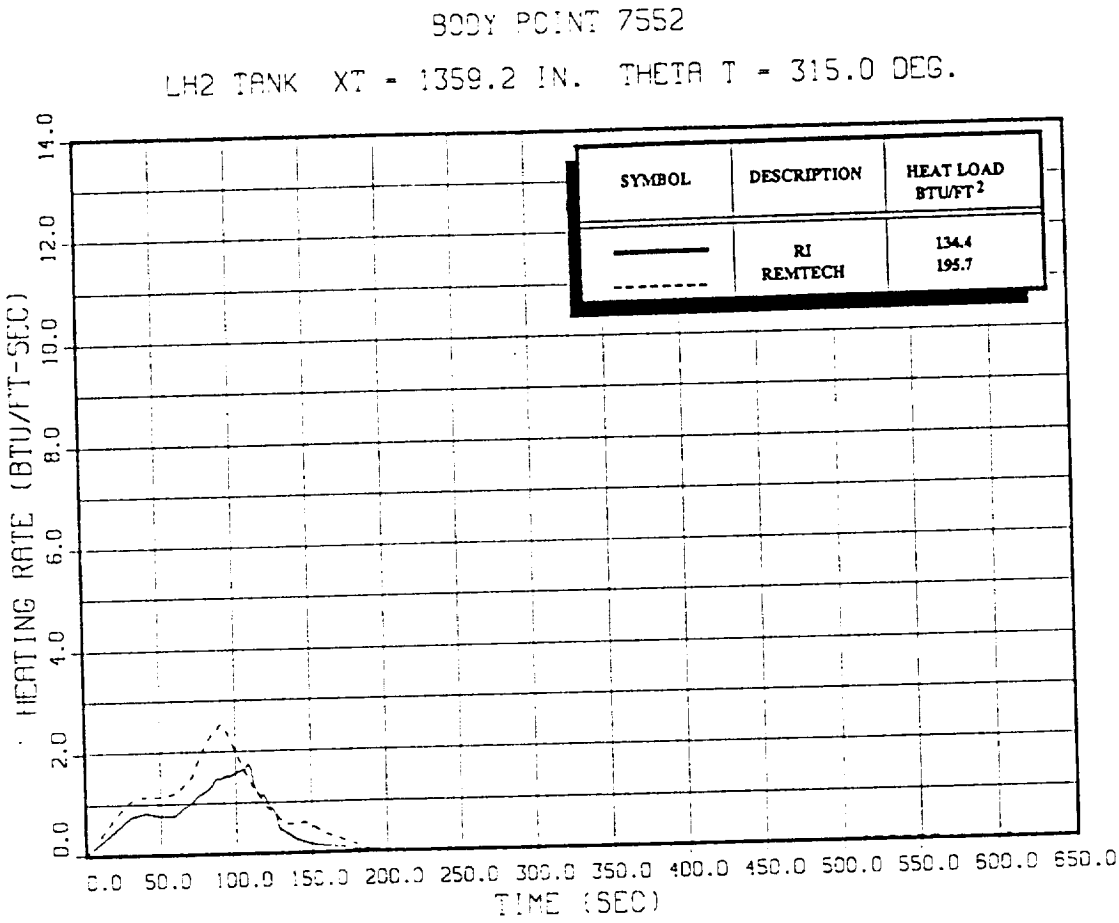

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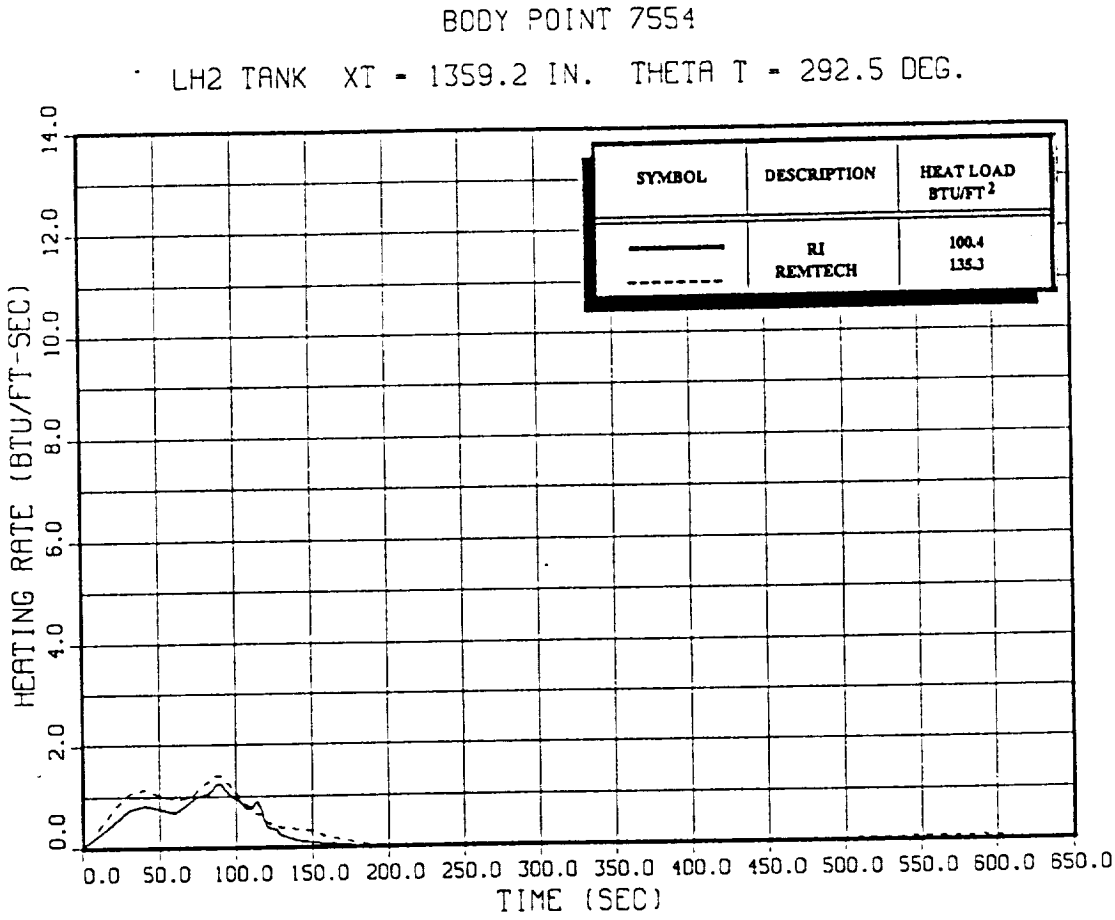
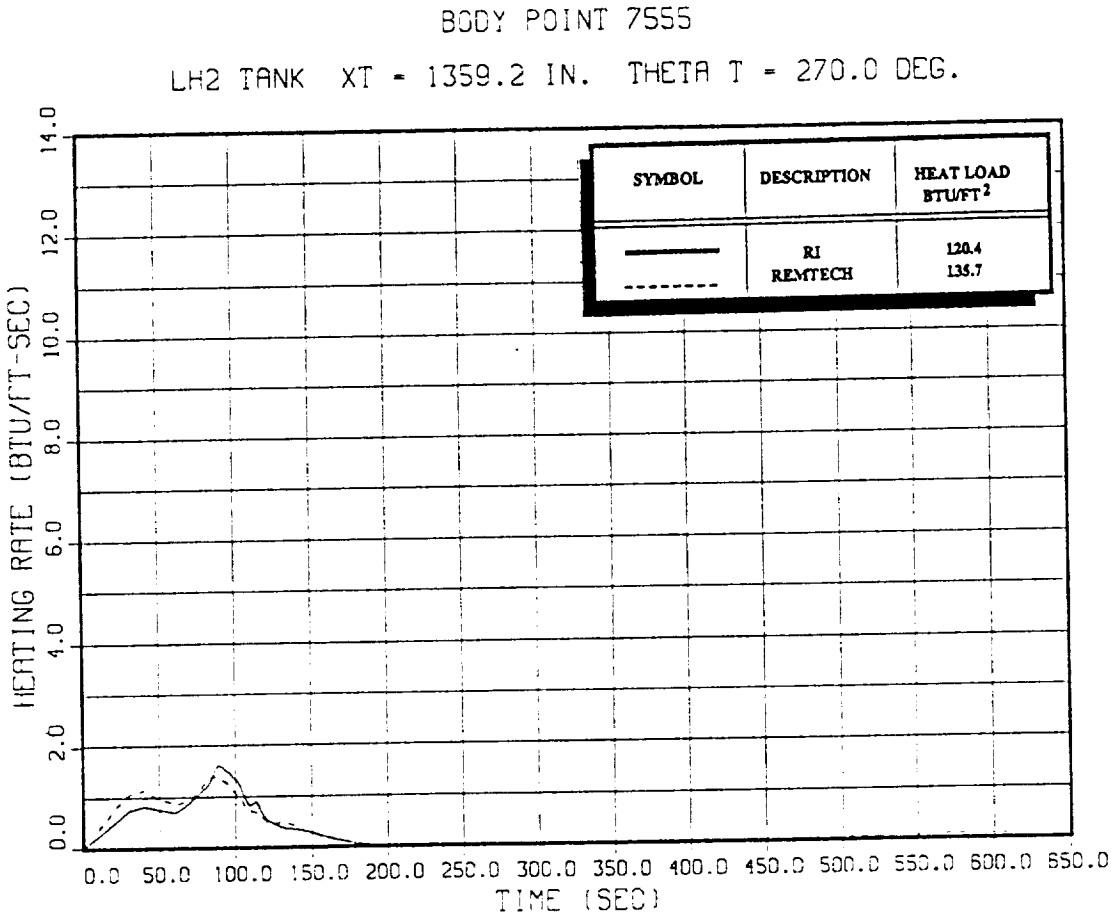


Agreement is acceptable; no TPS impact.



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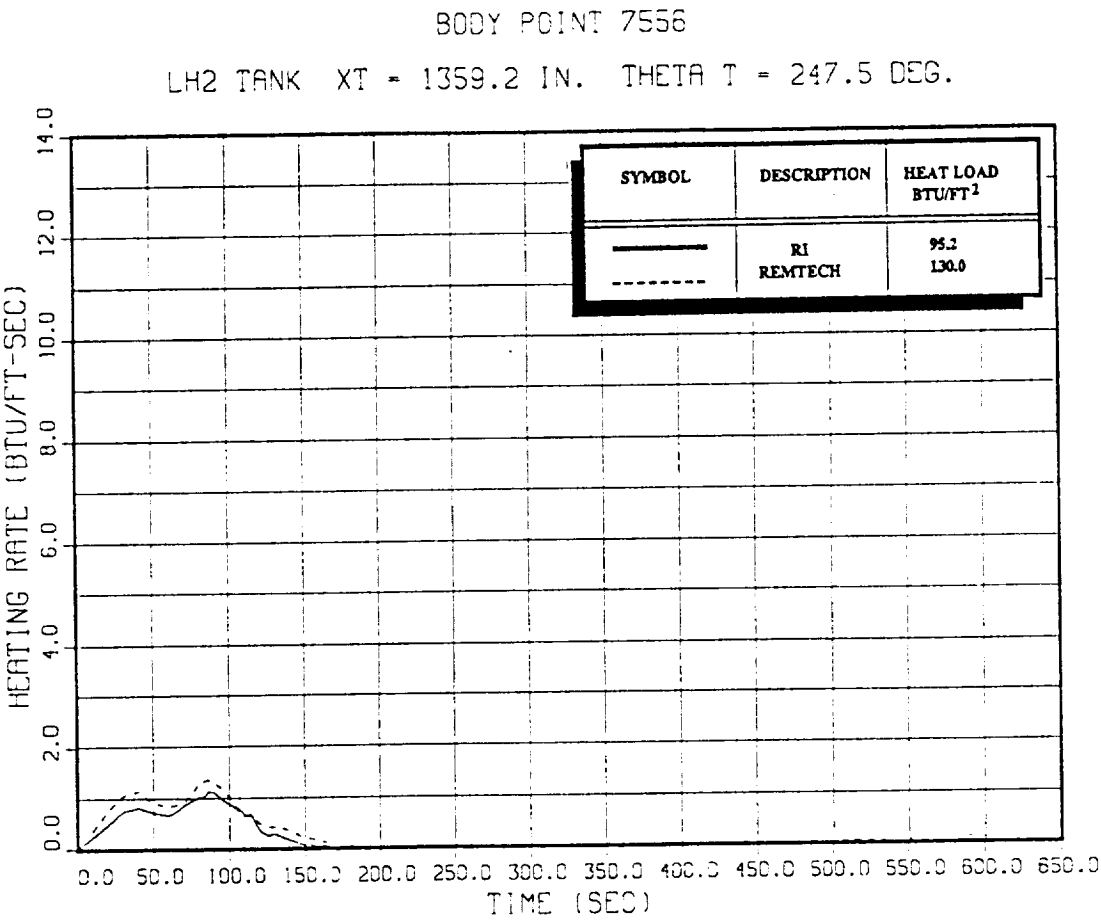

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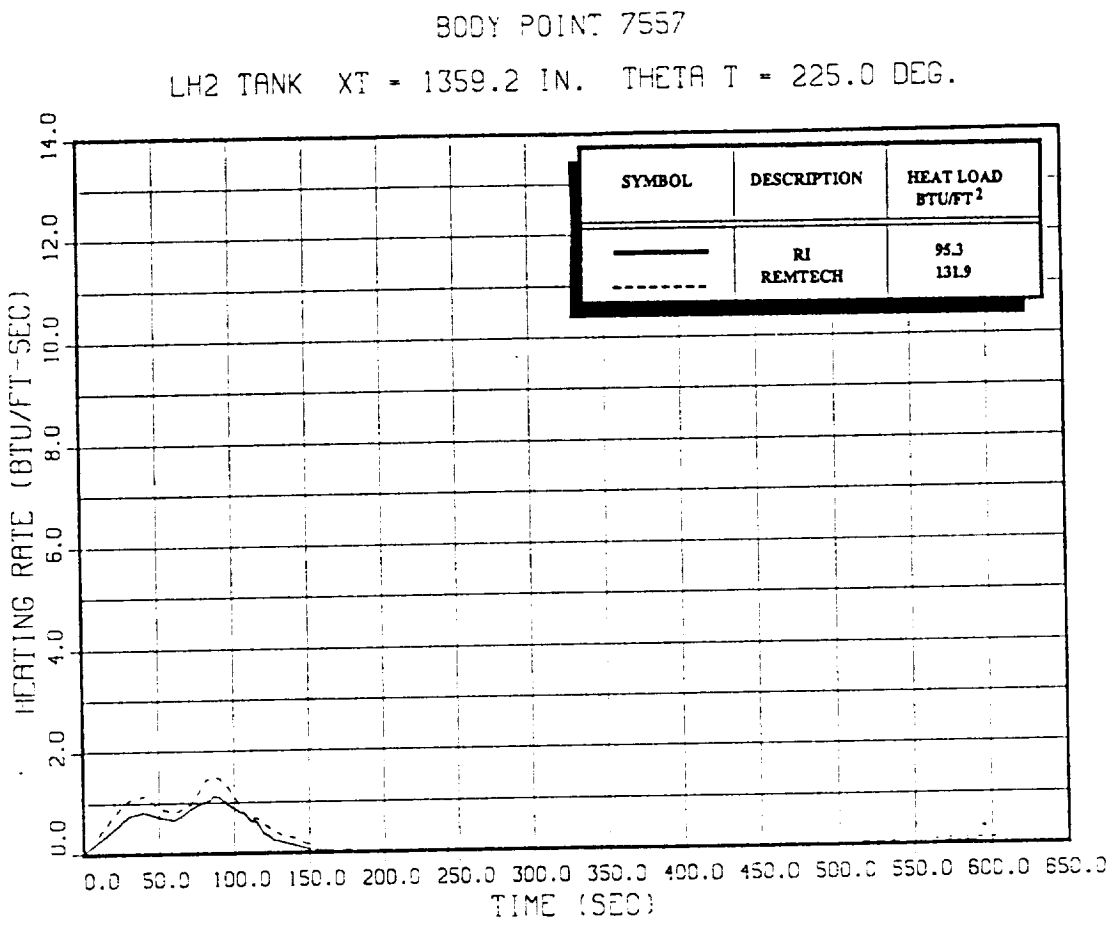

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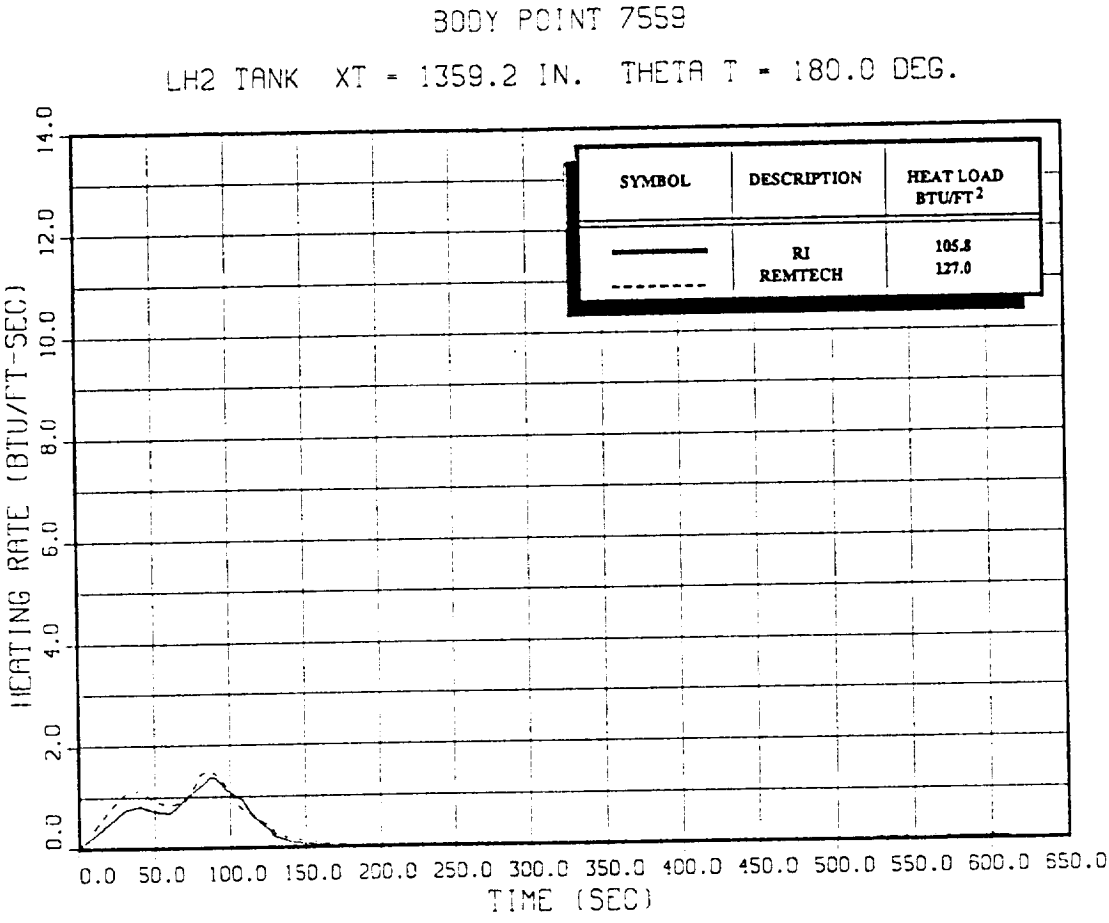

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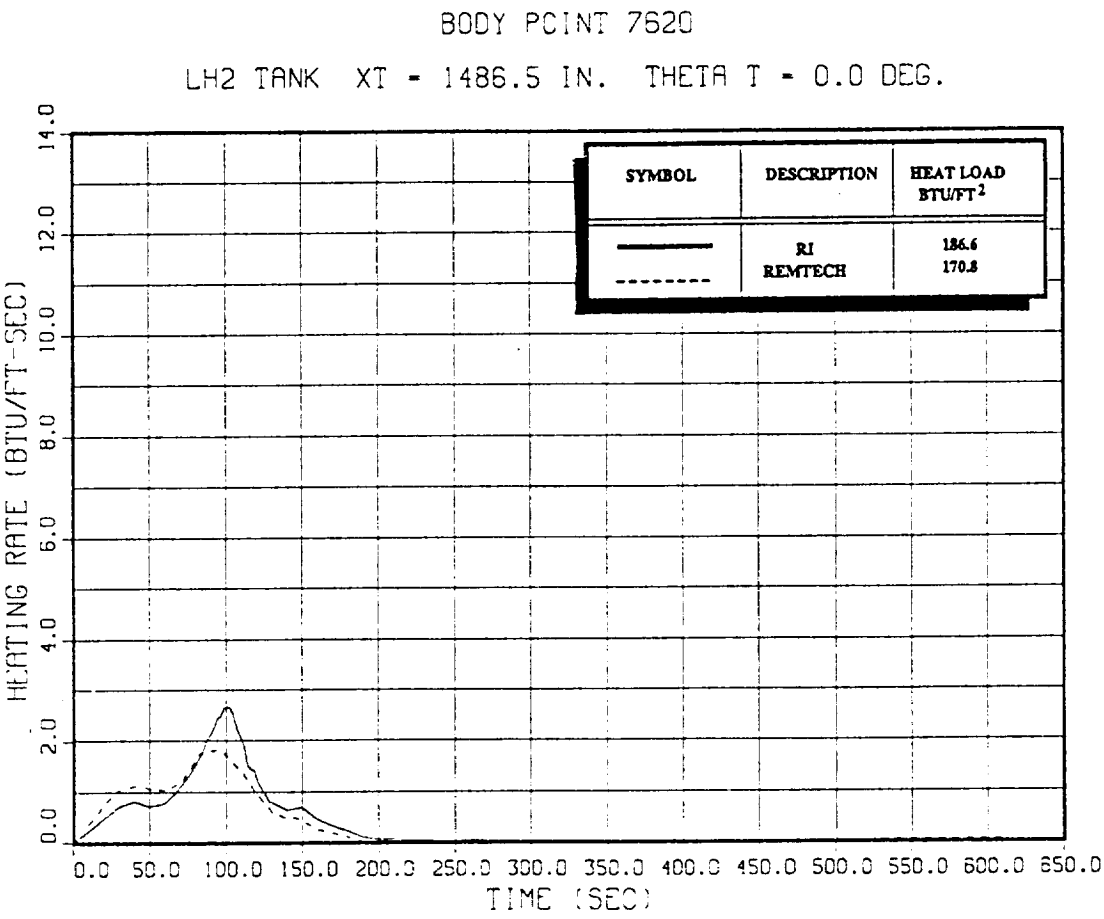

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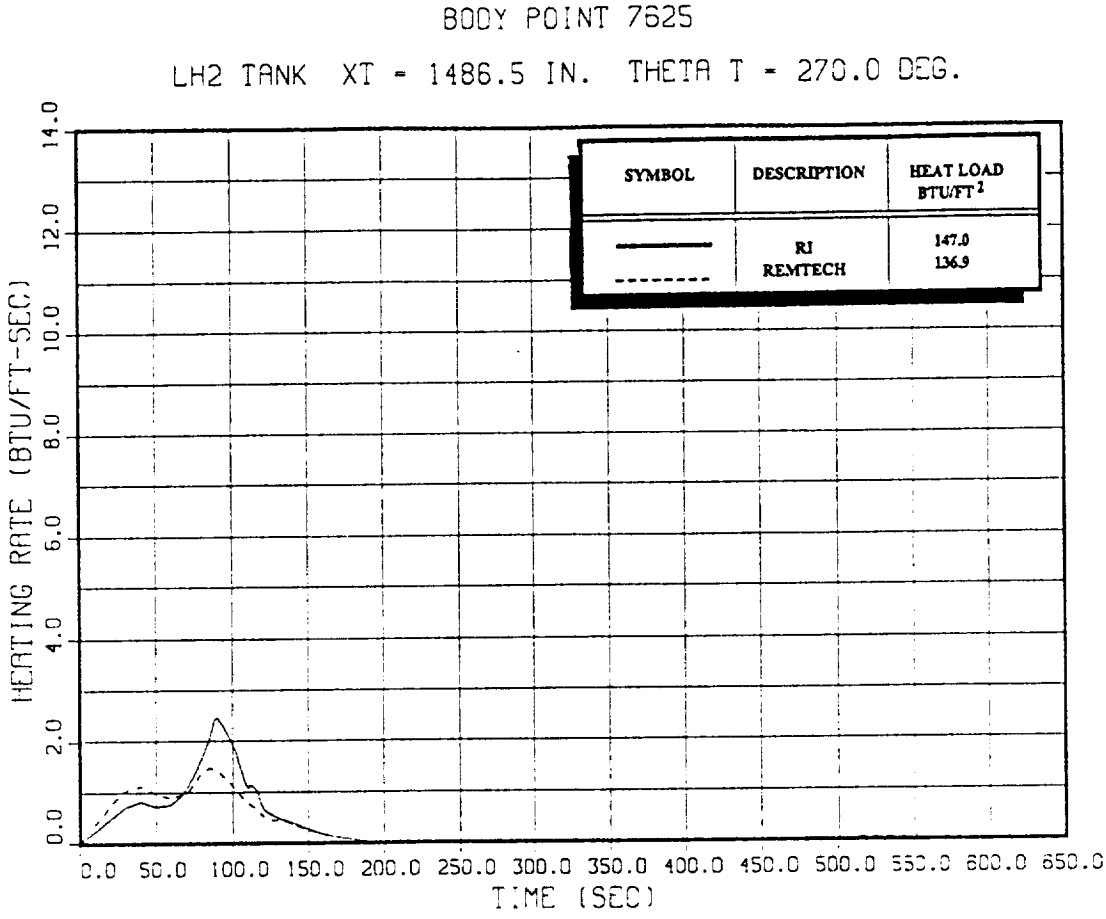

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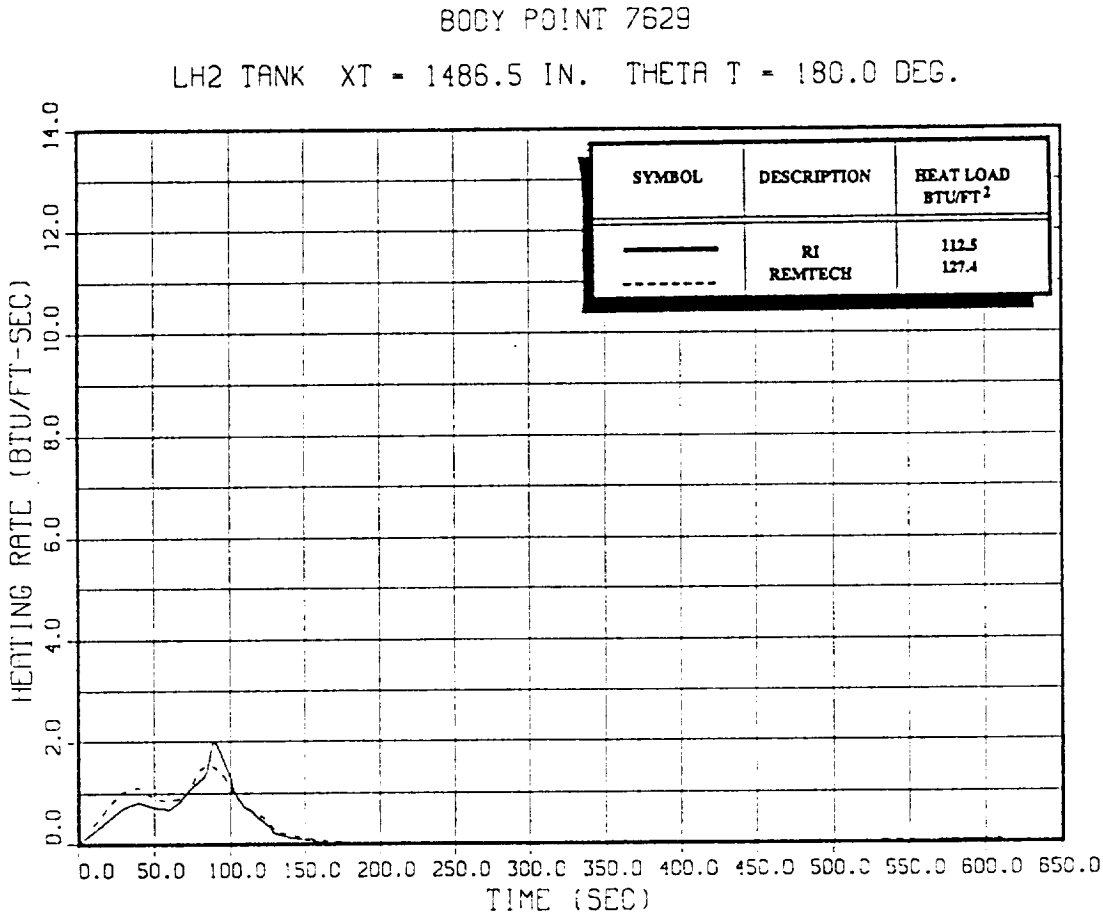

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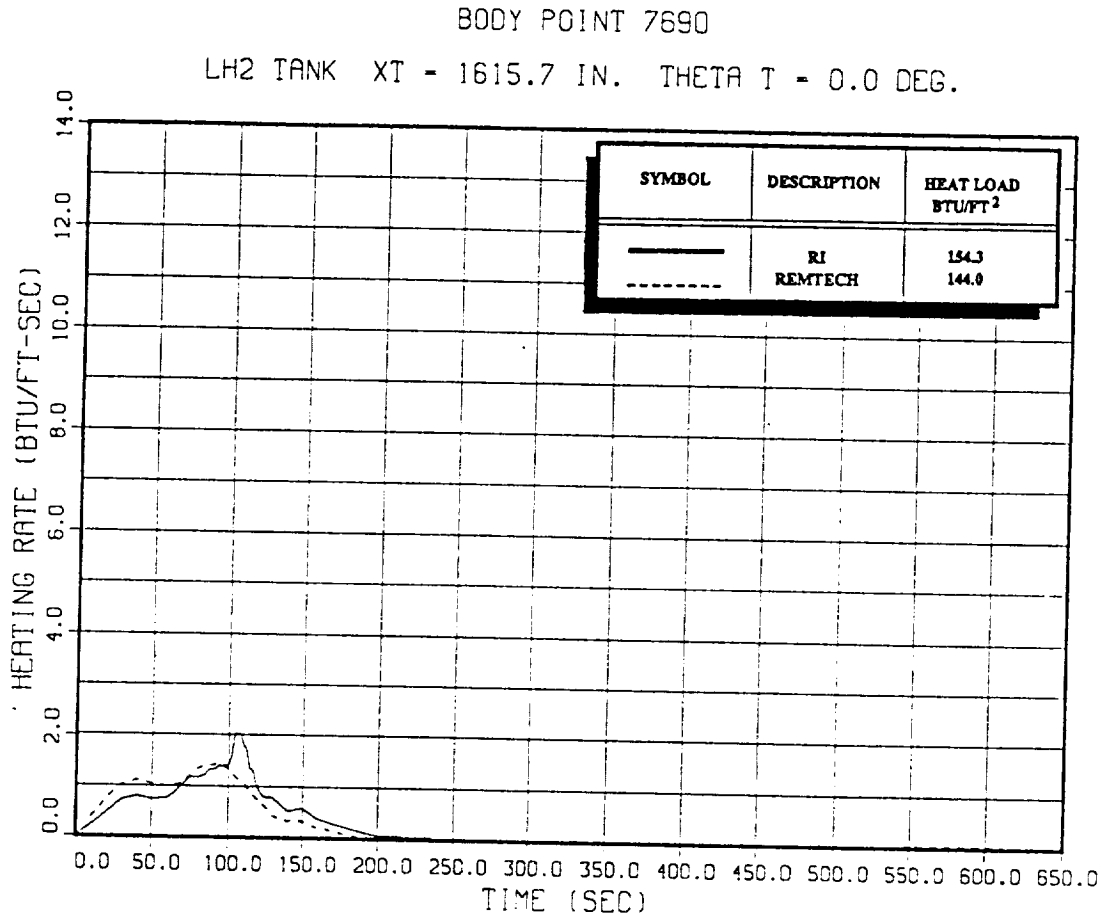

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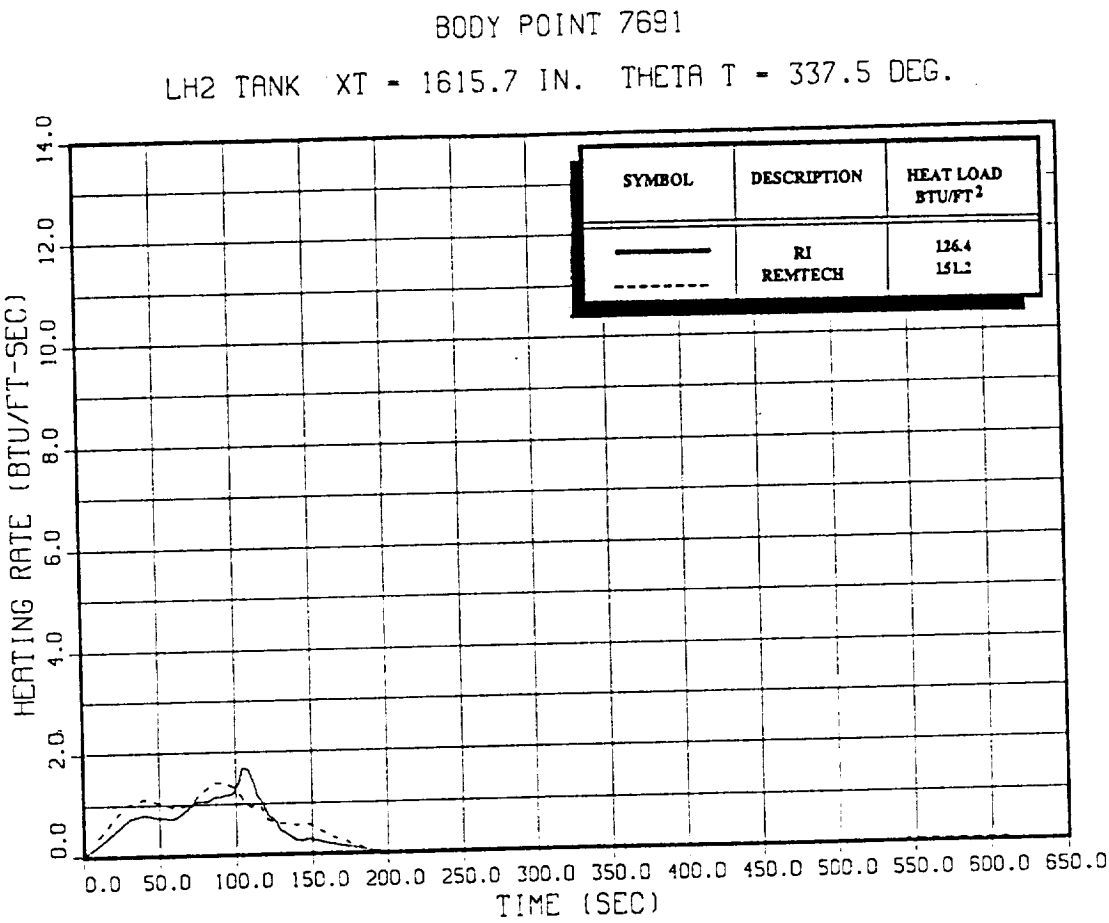

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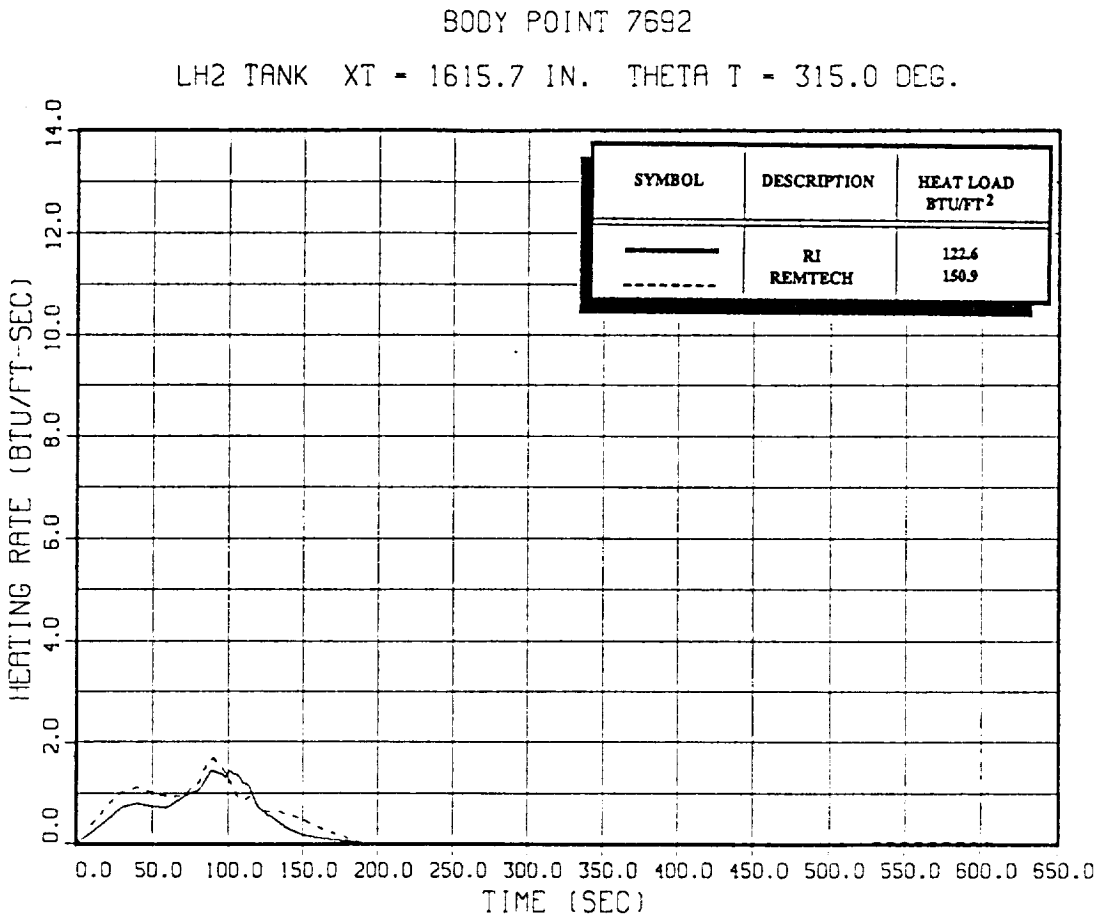

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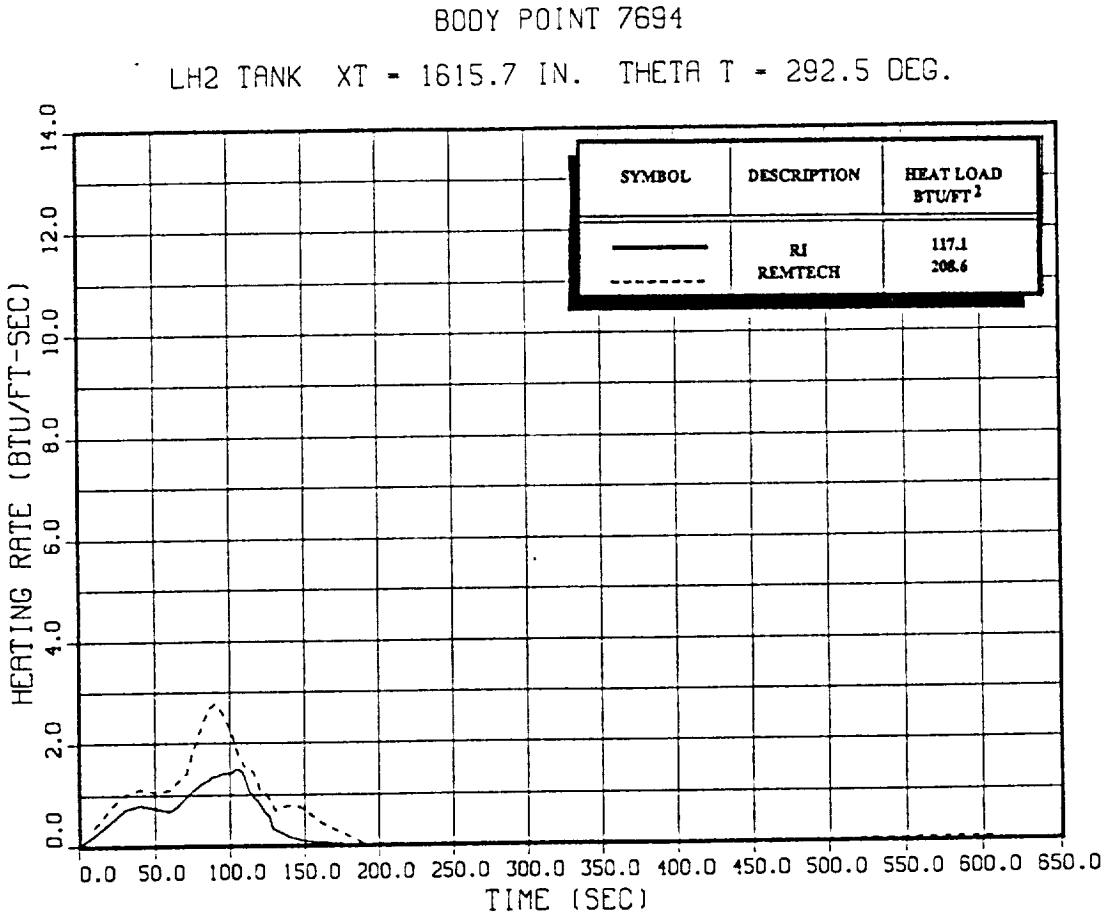

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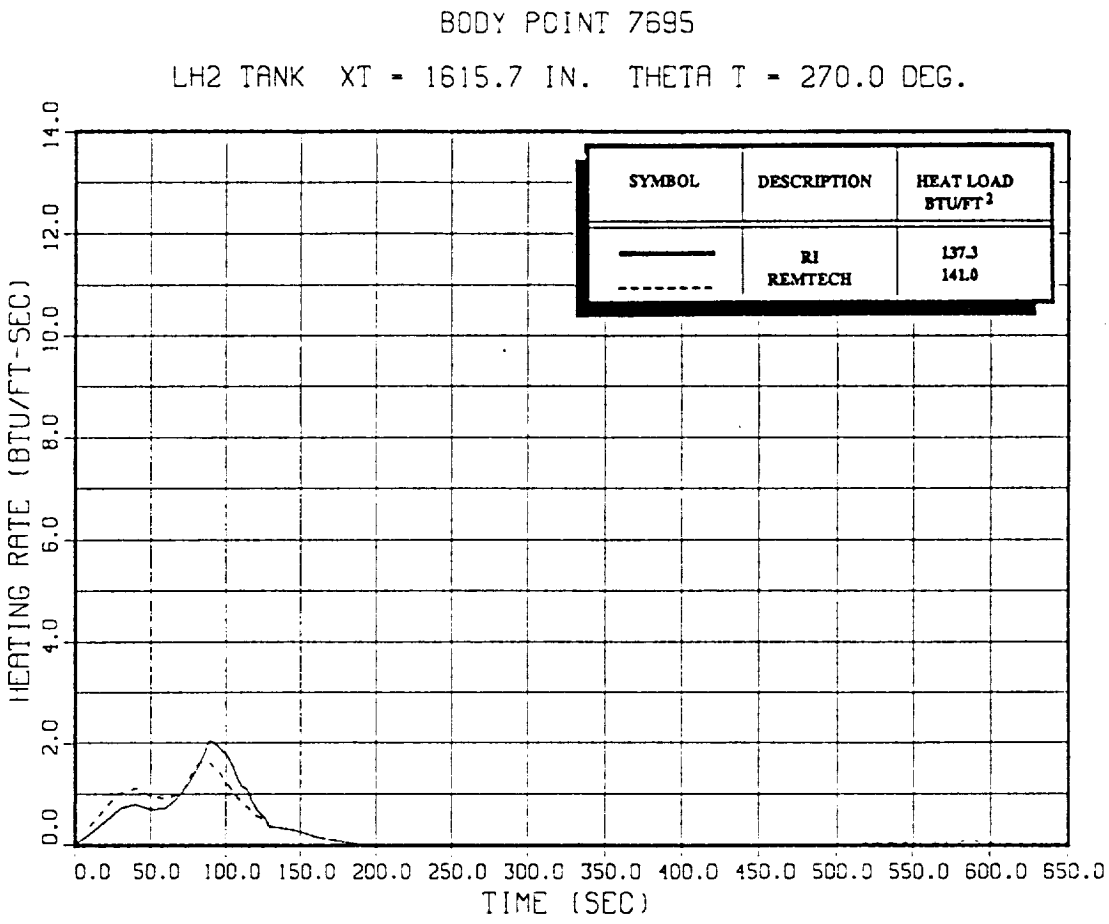

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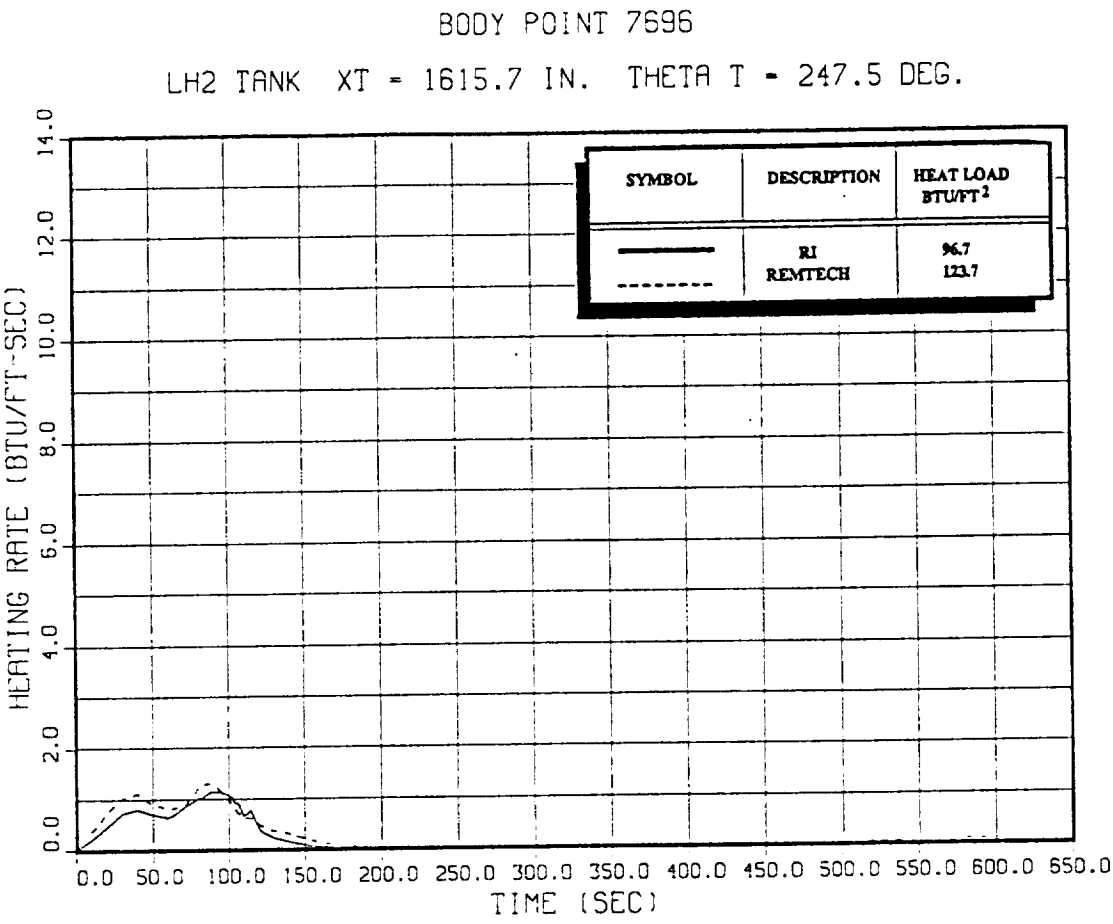

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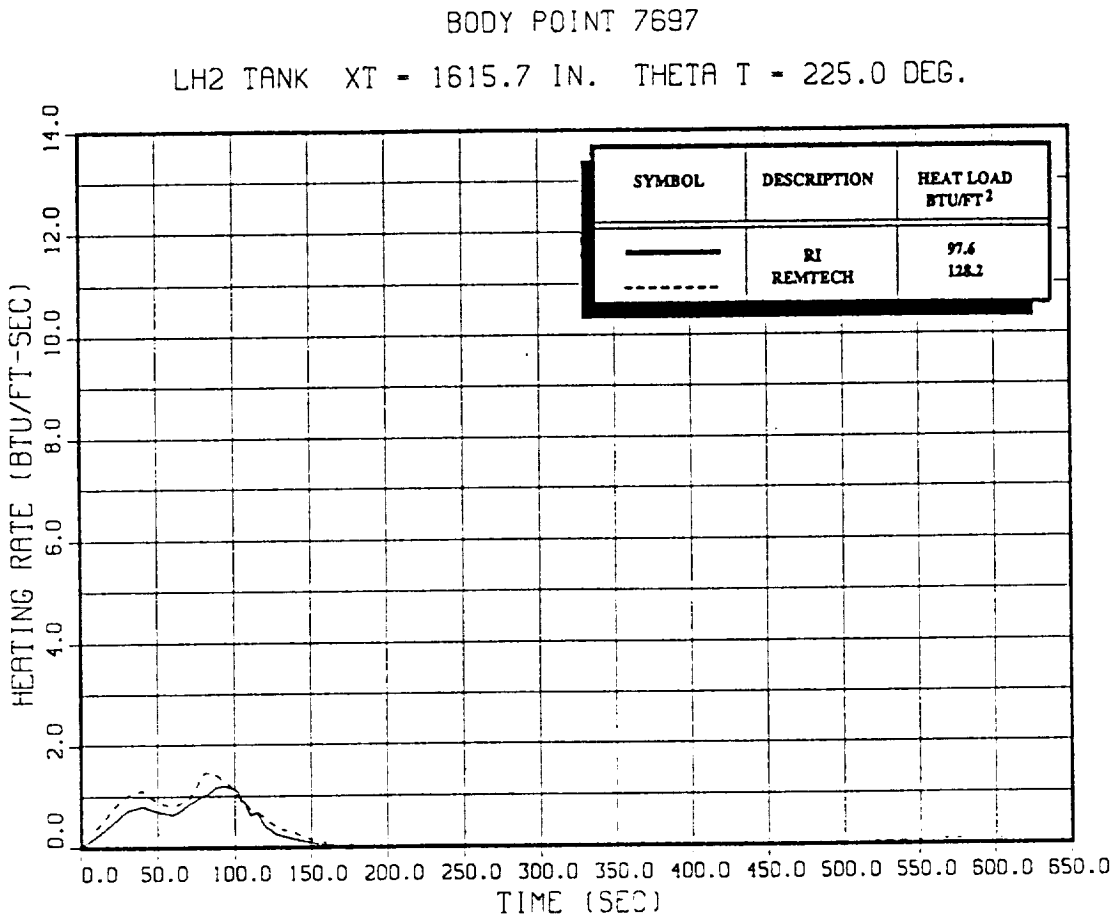

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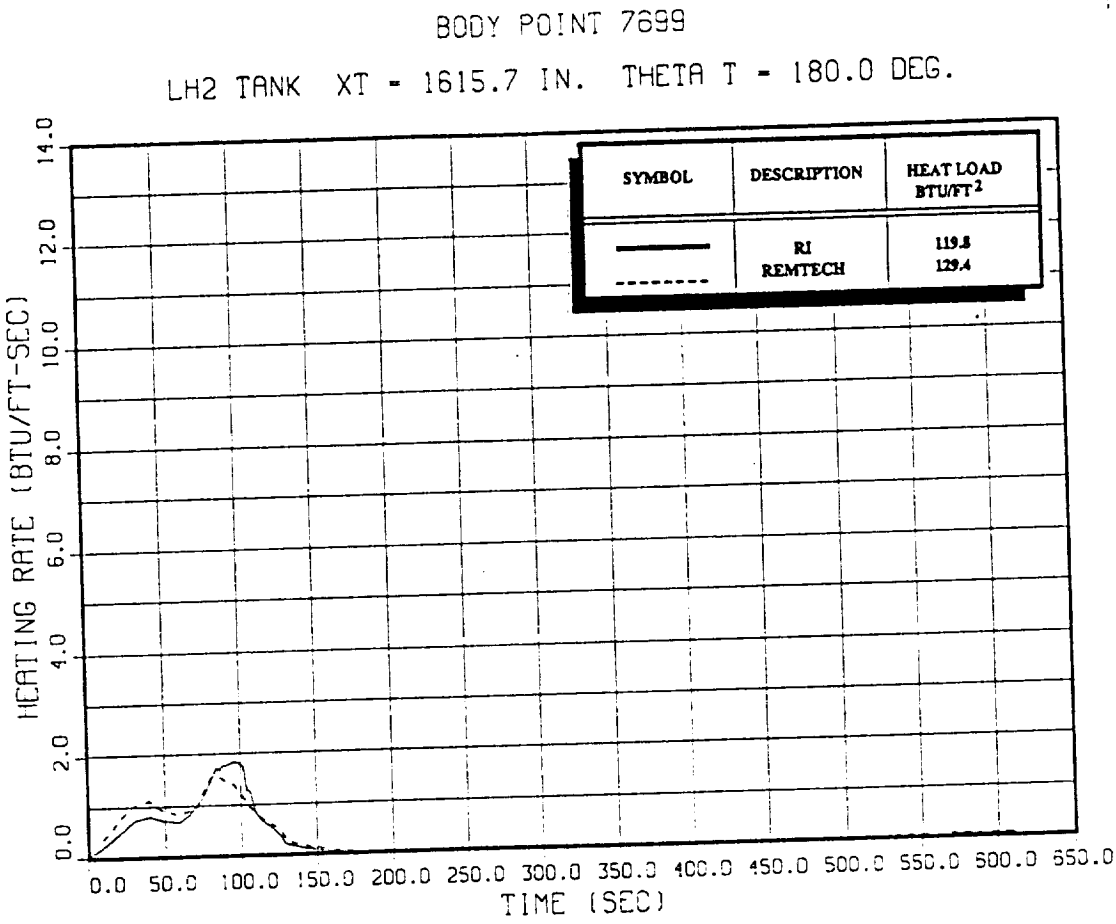

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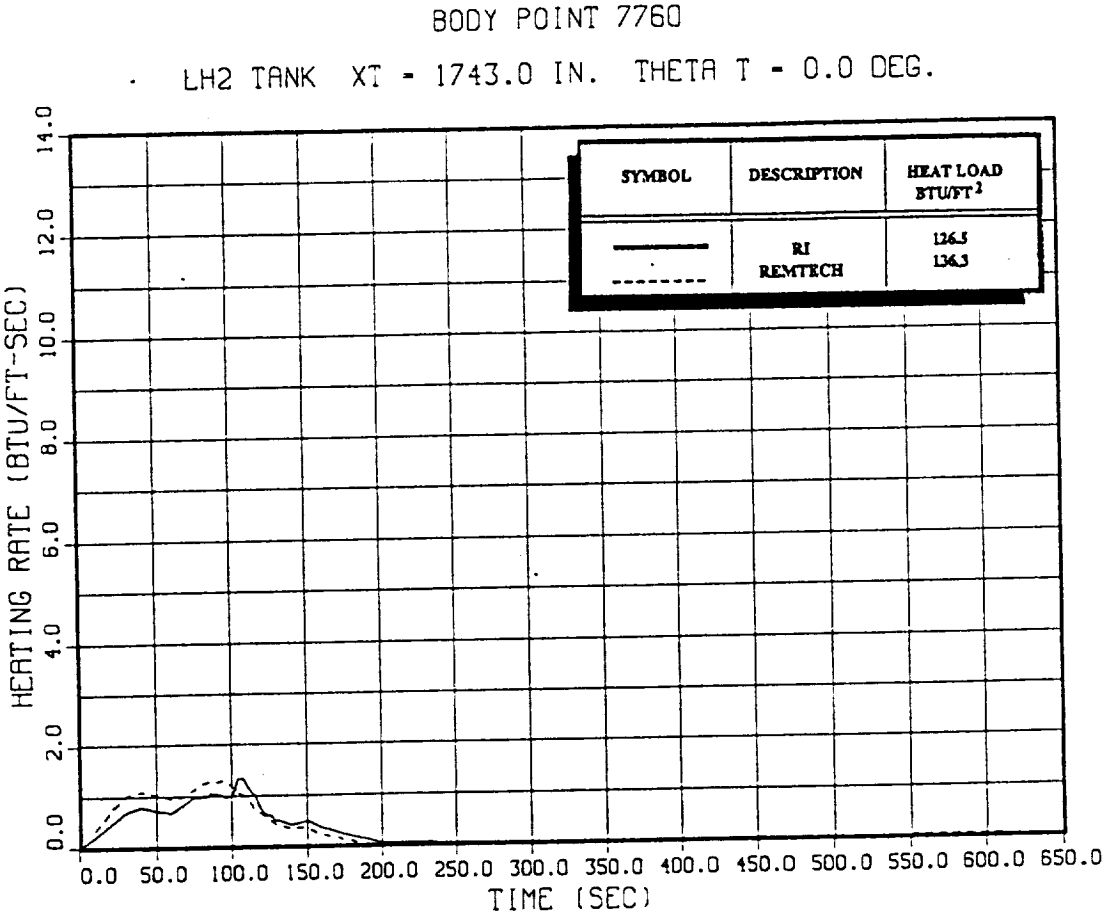

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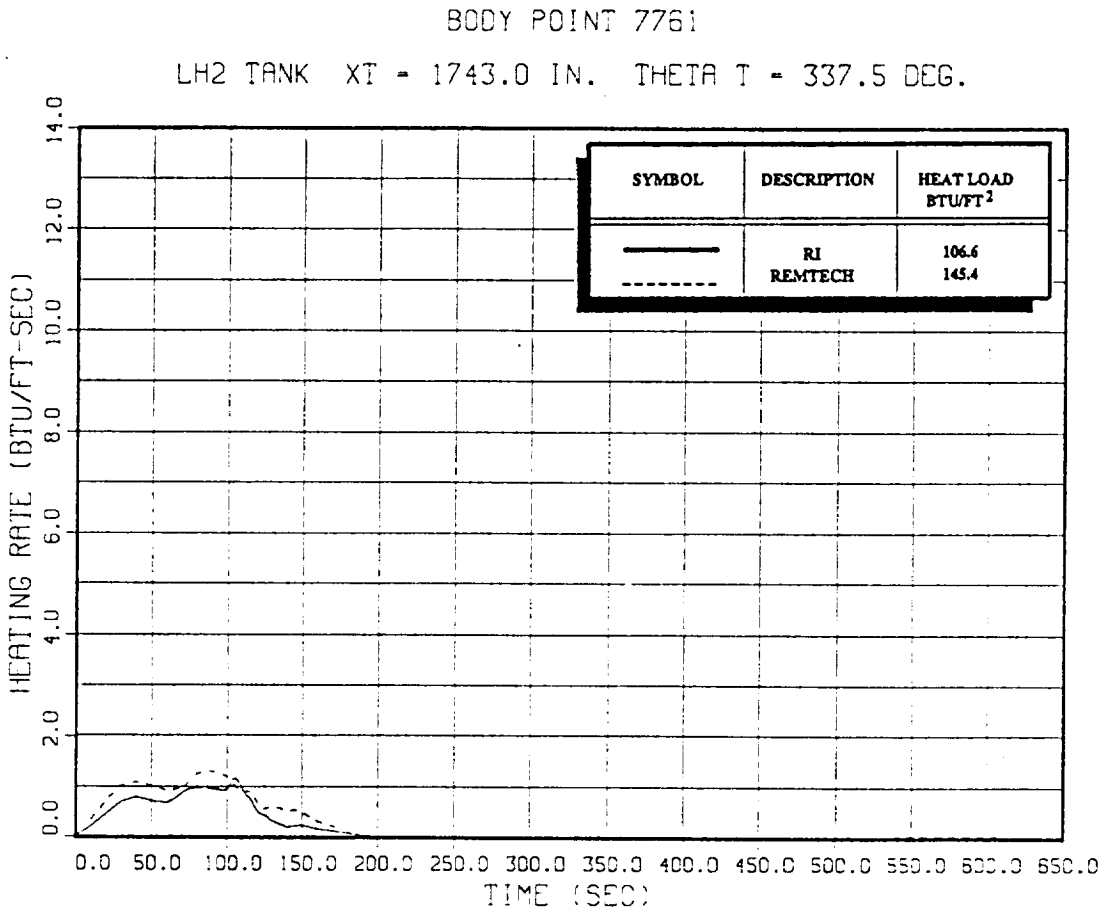

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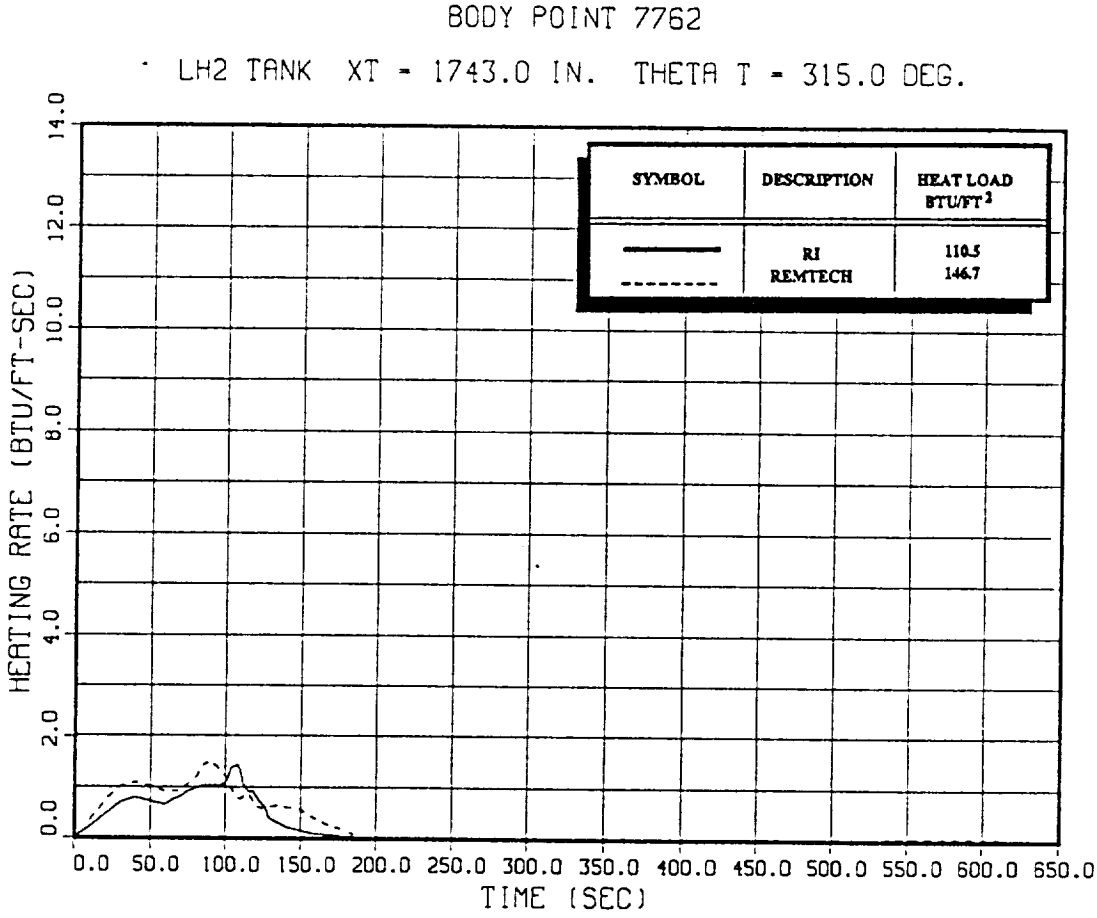

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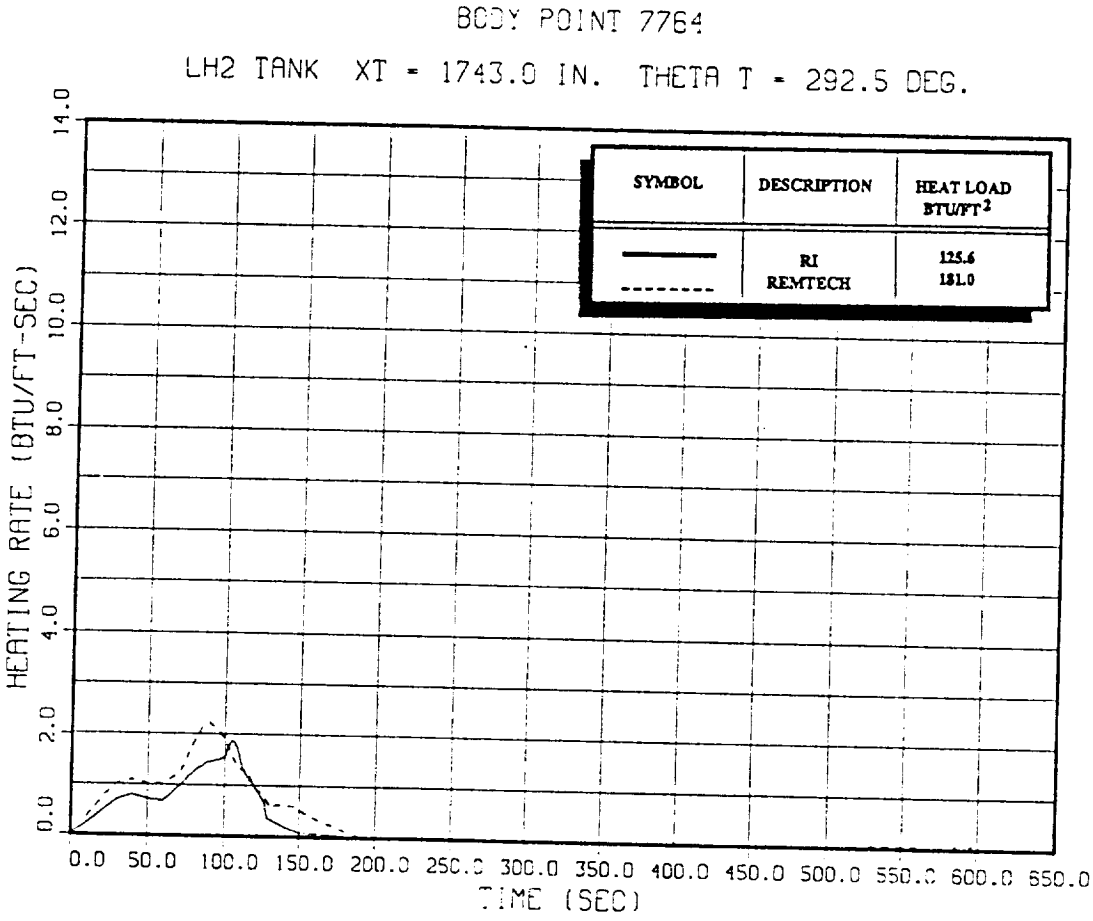

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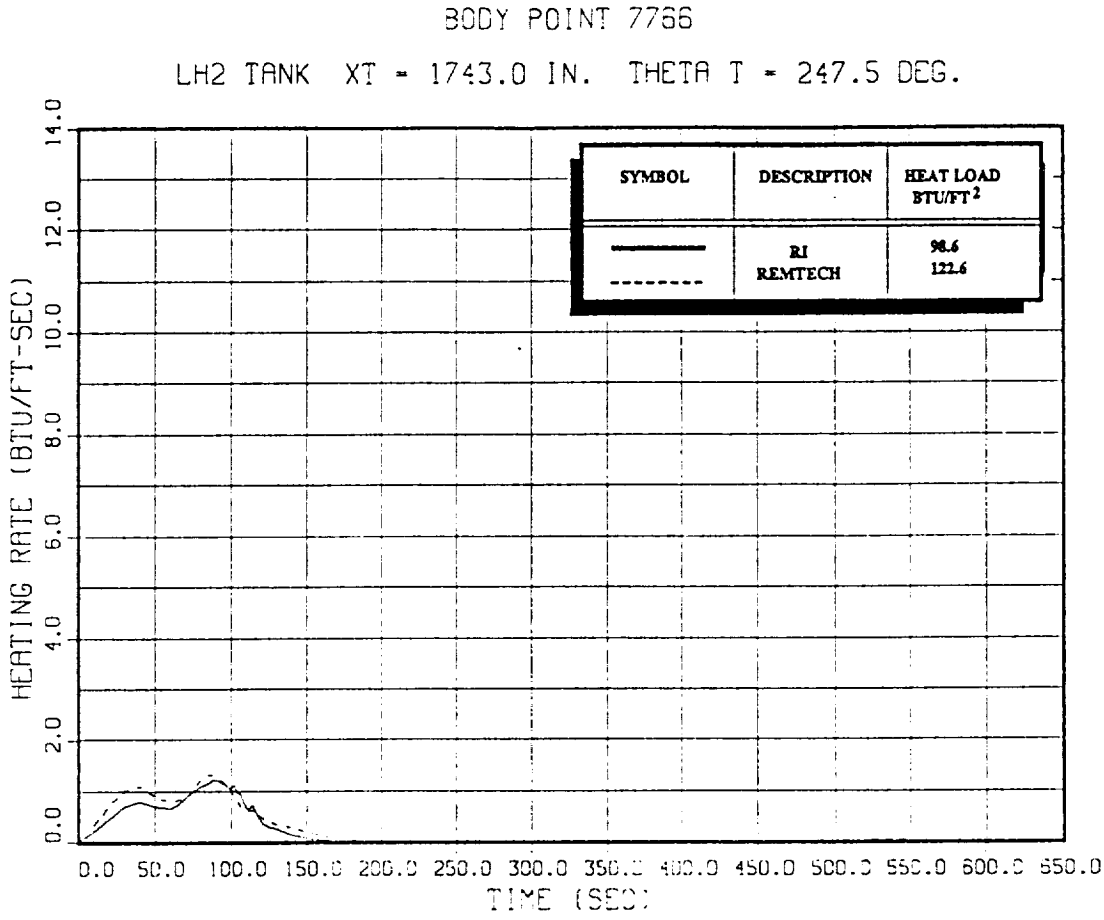

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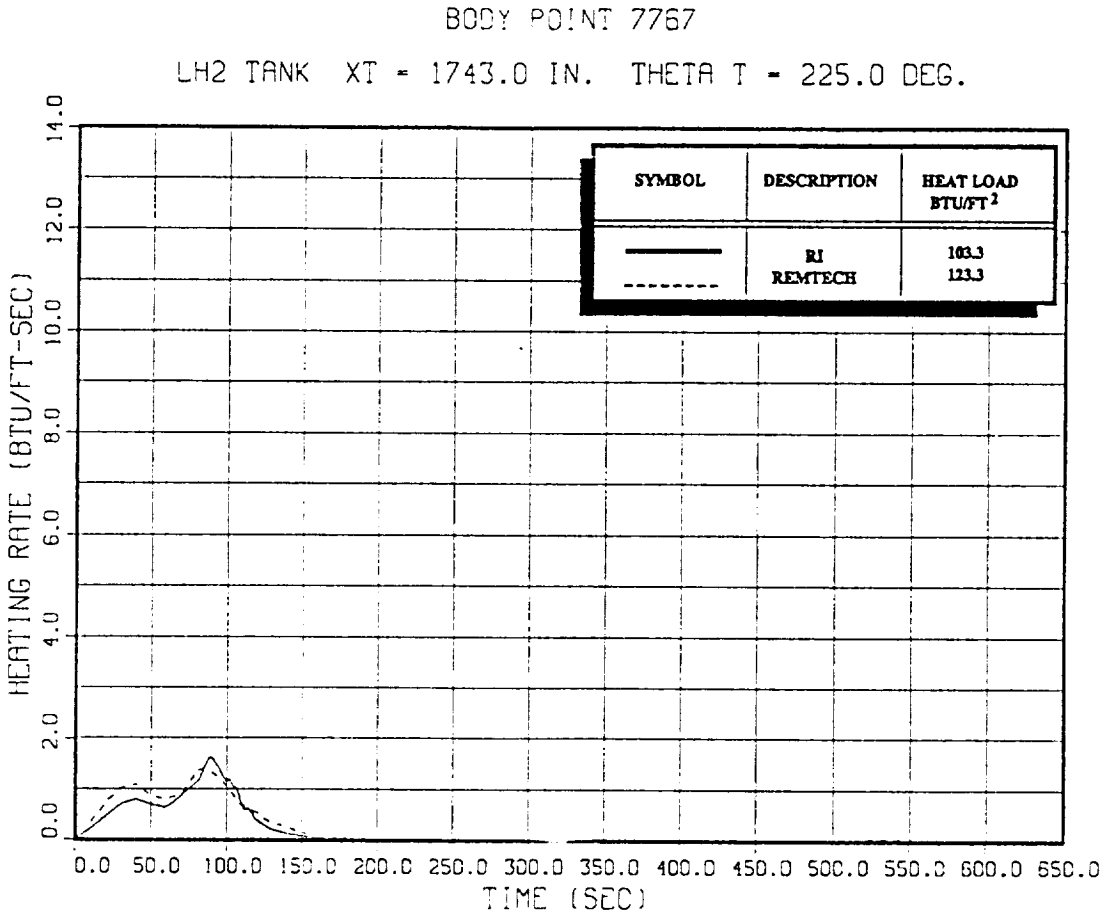

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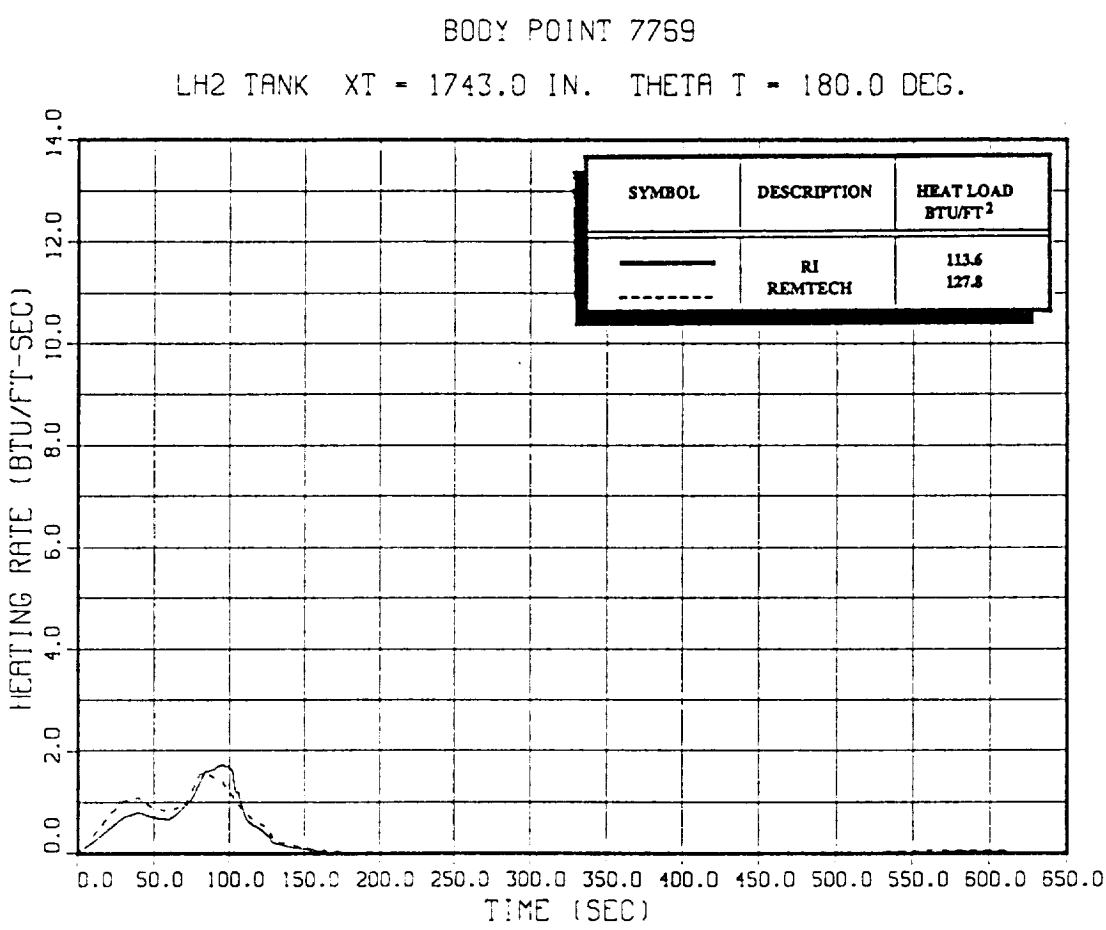

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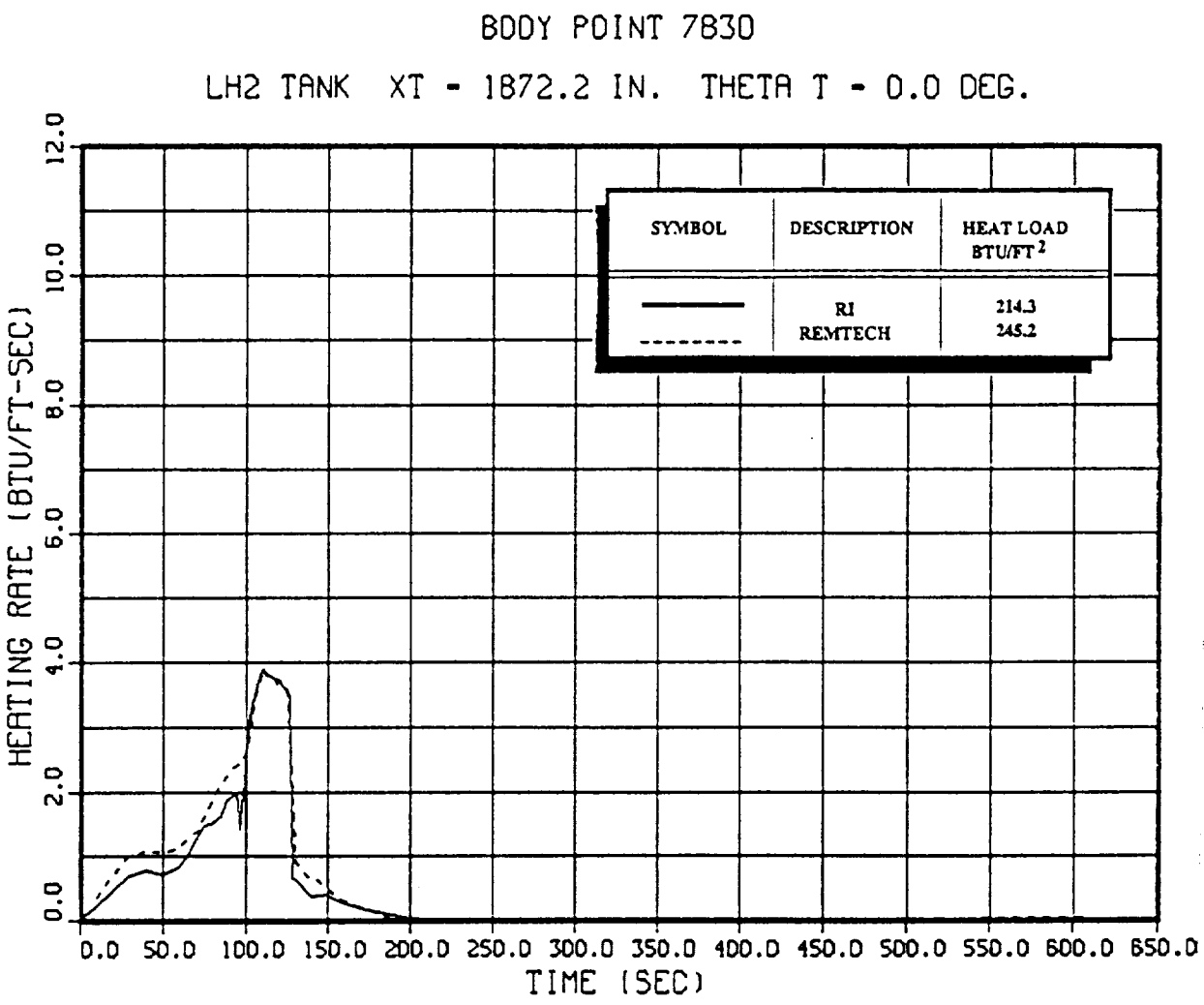

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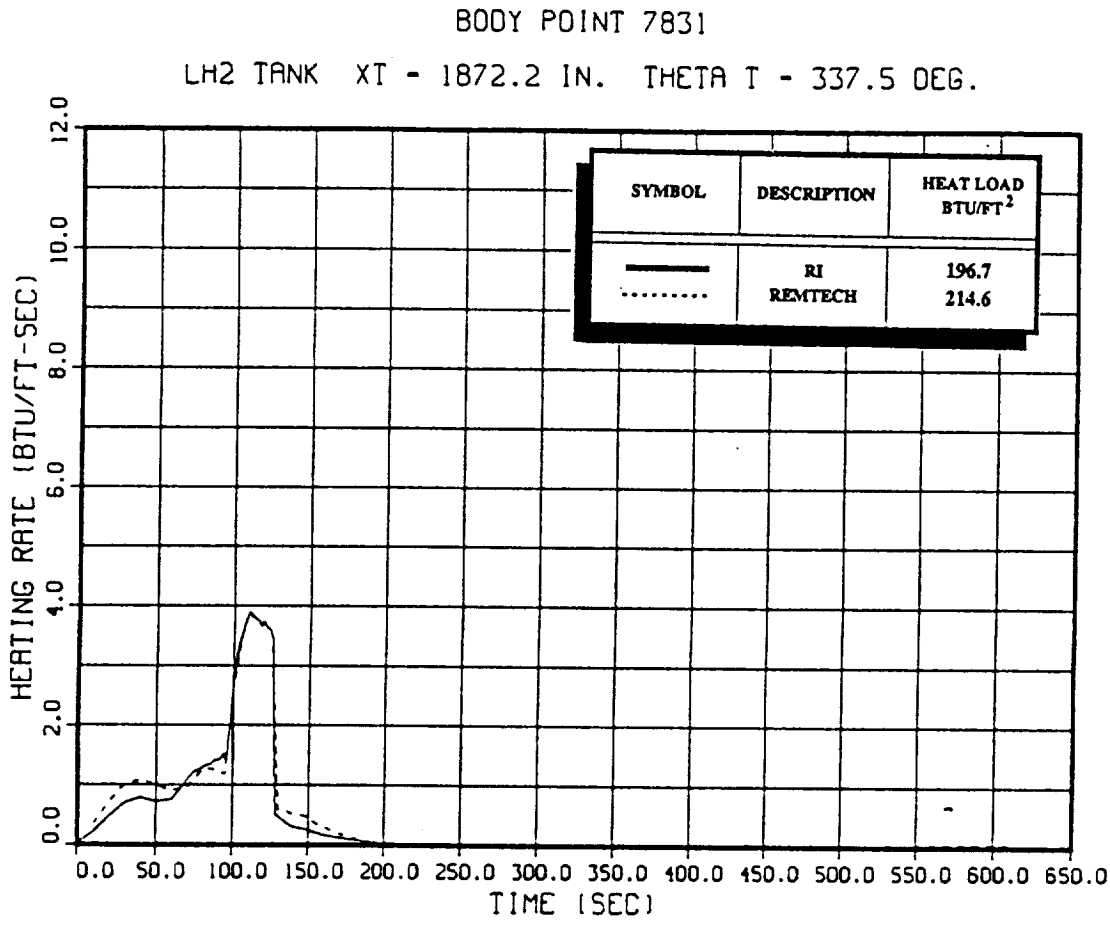

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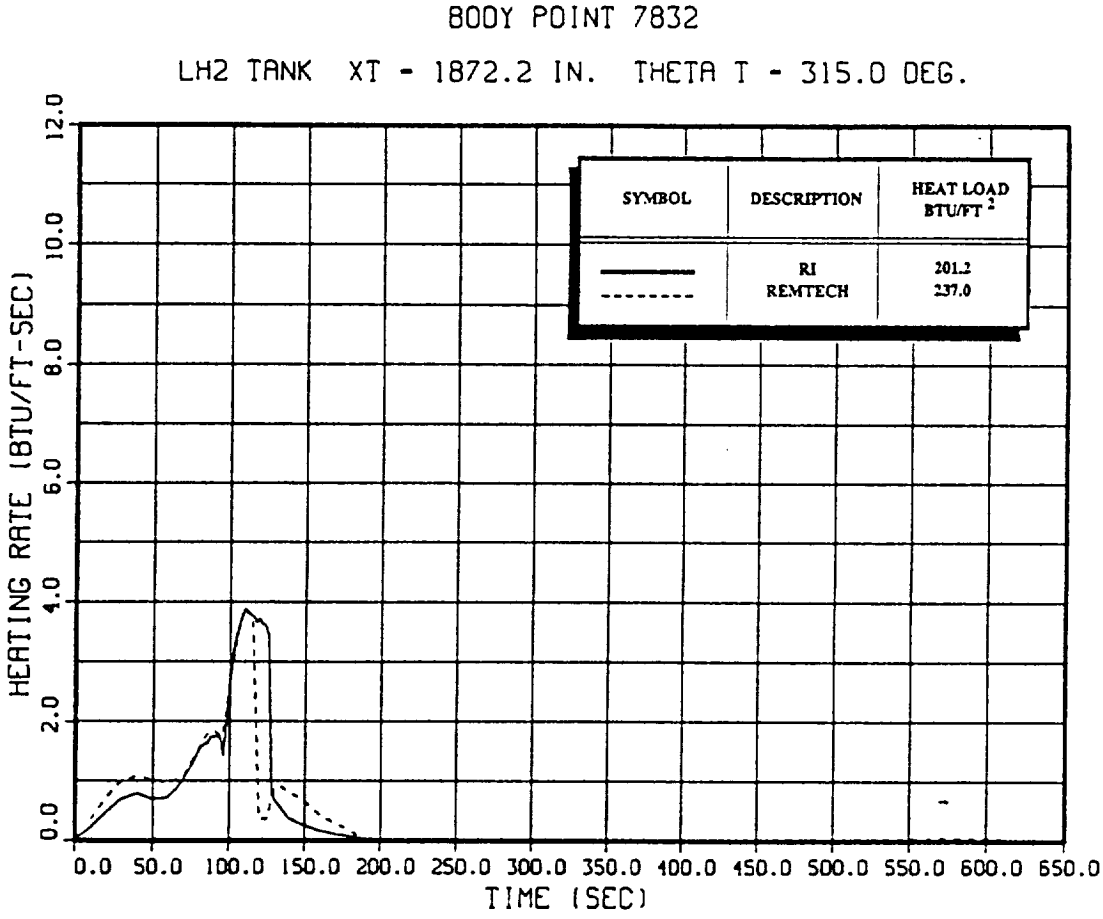

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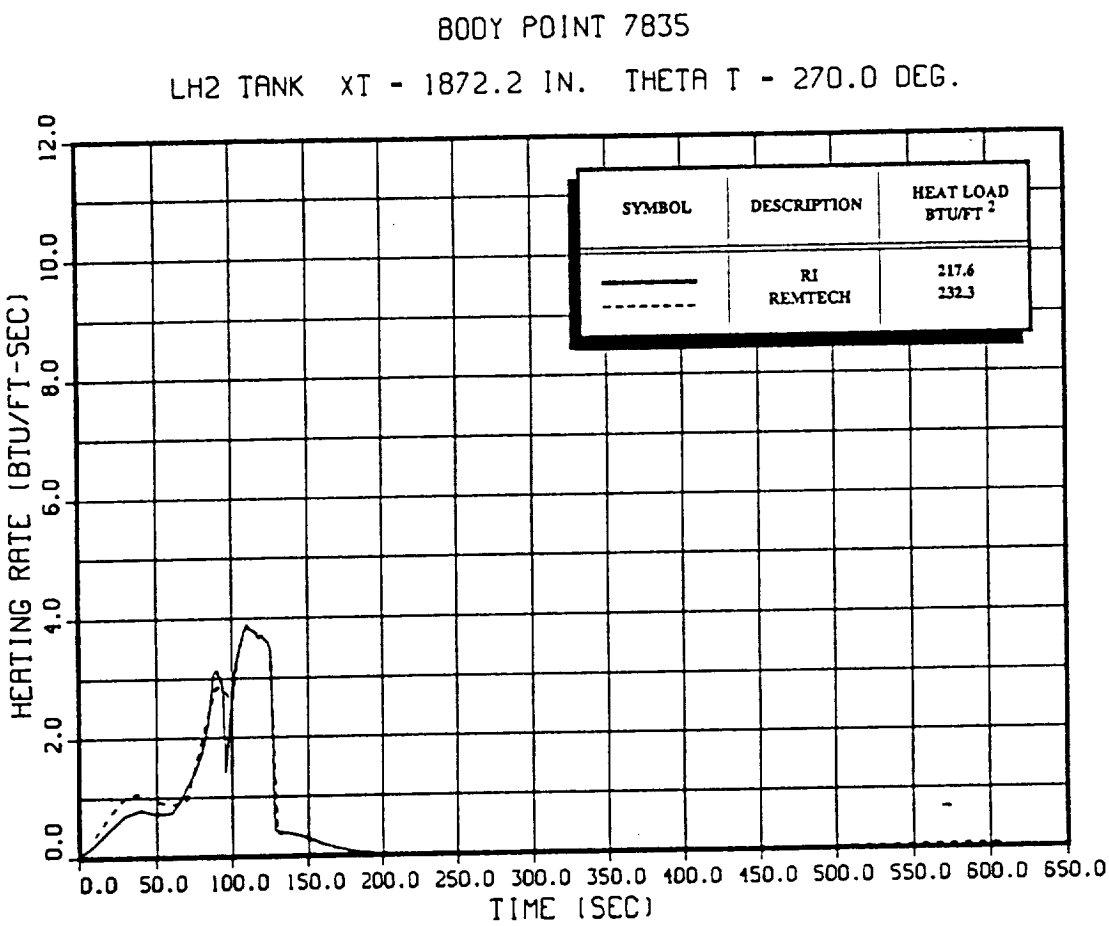

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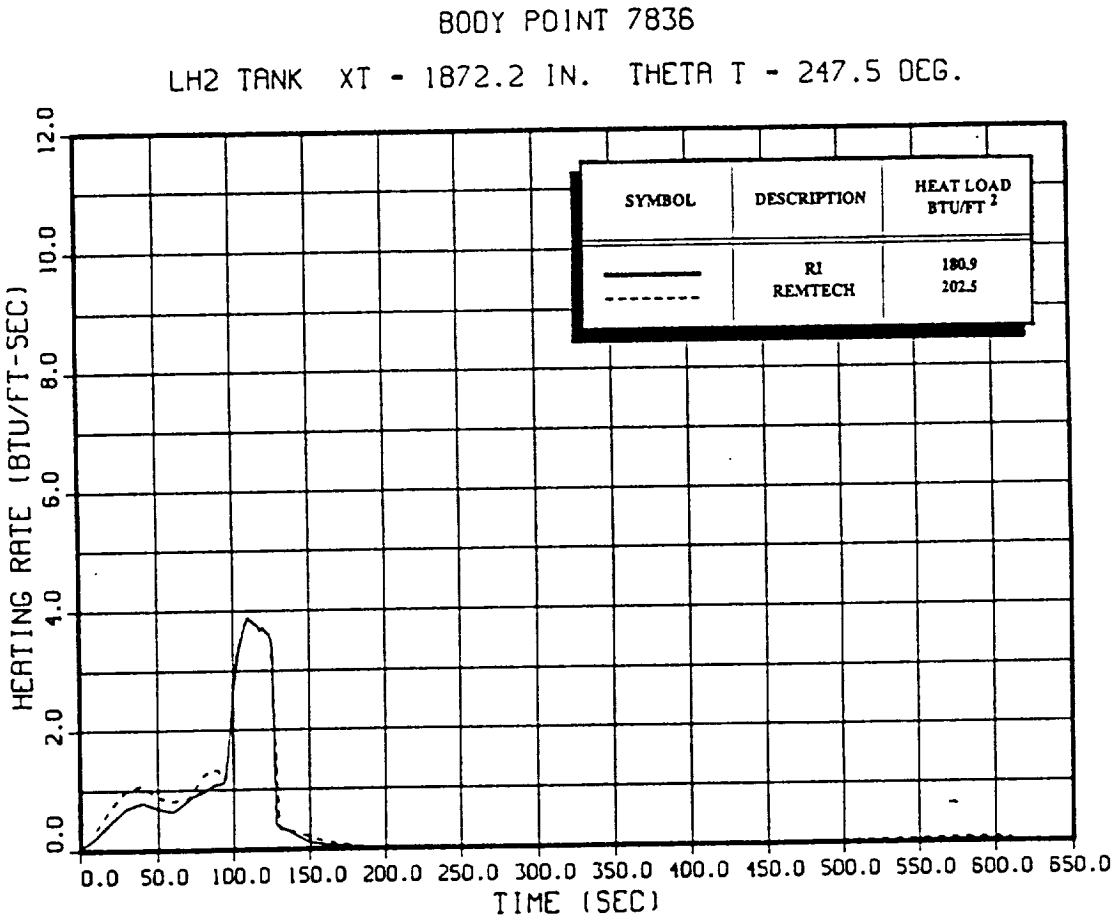

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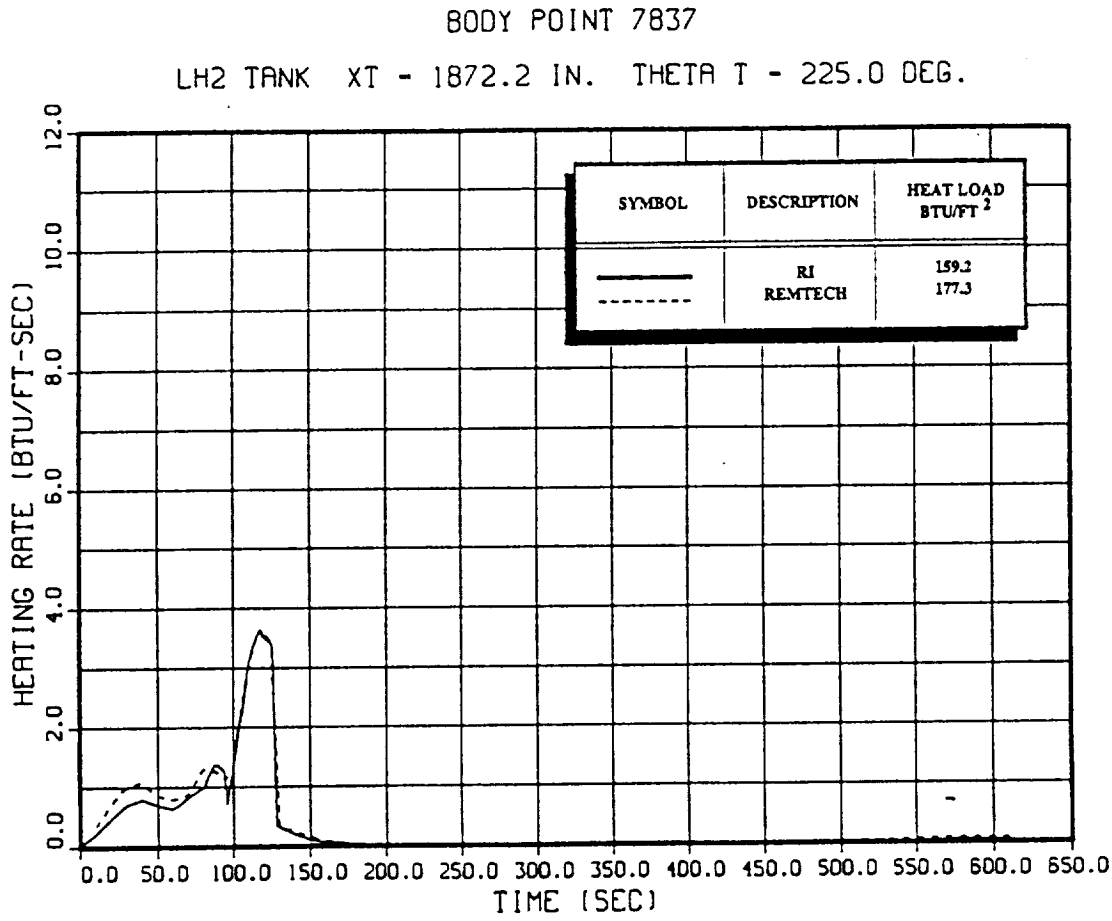

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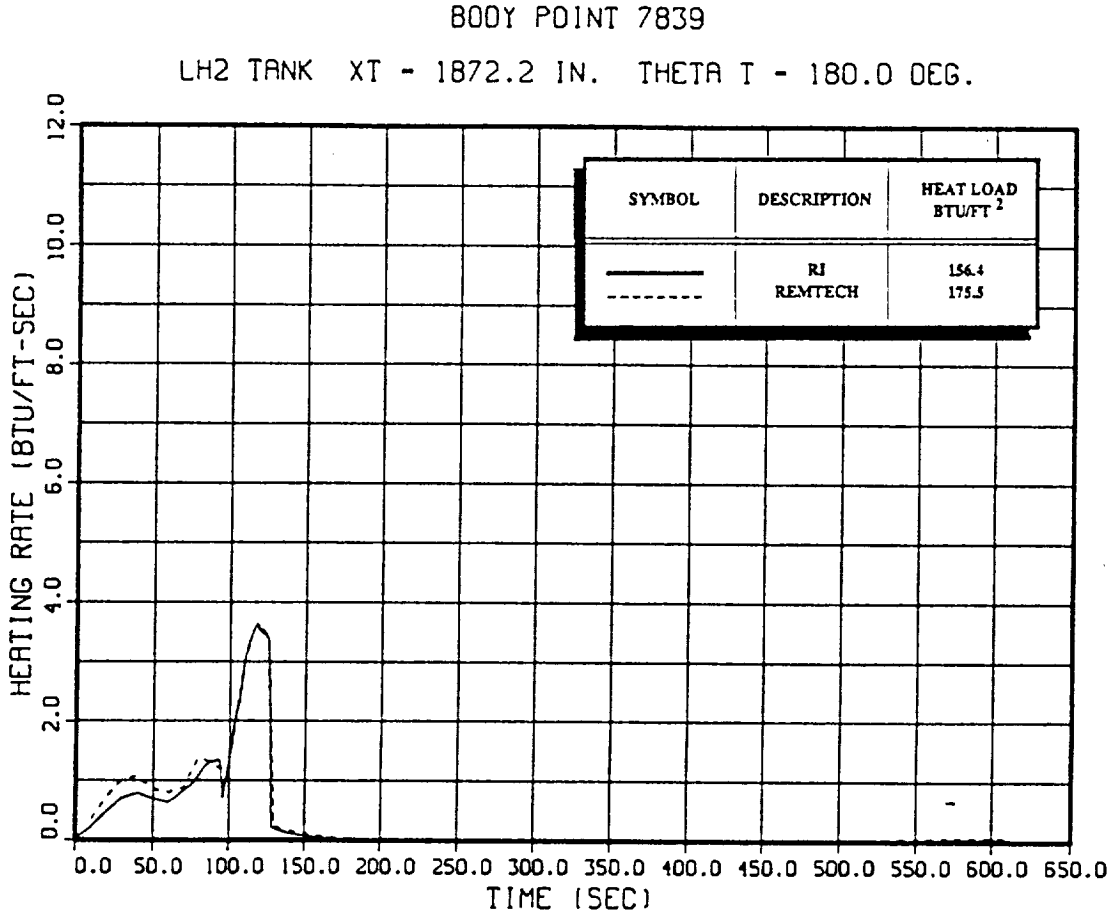

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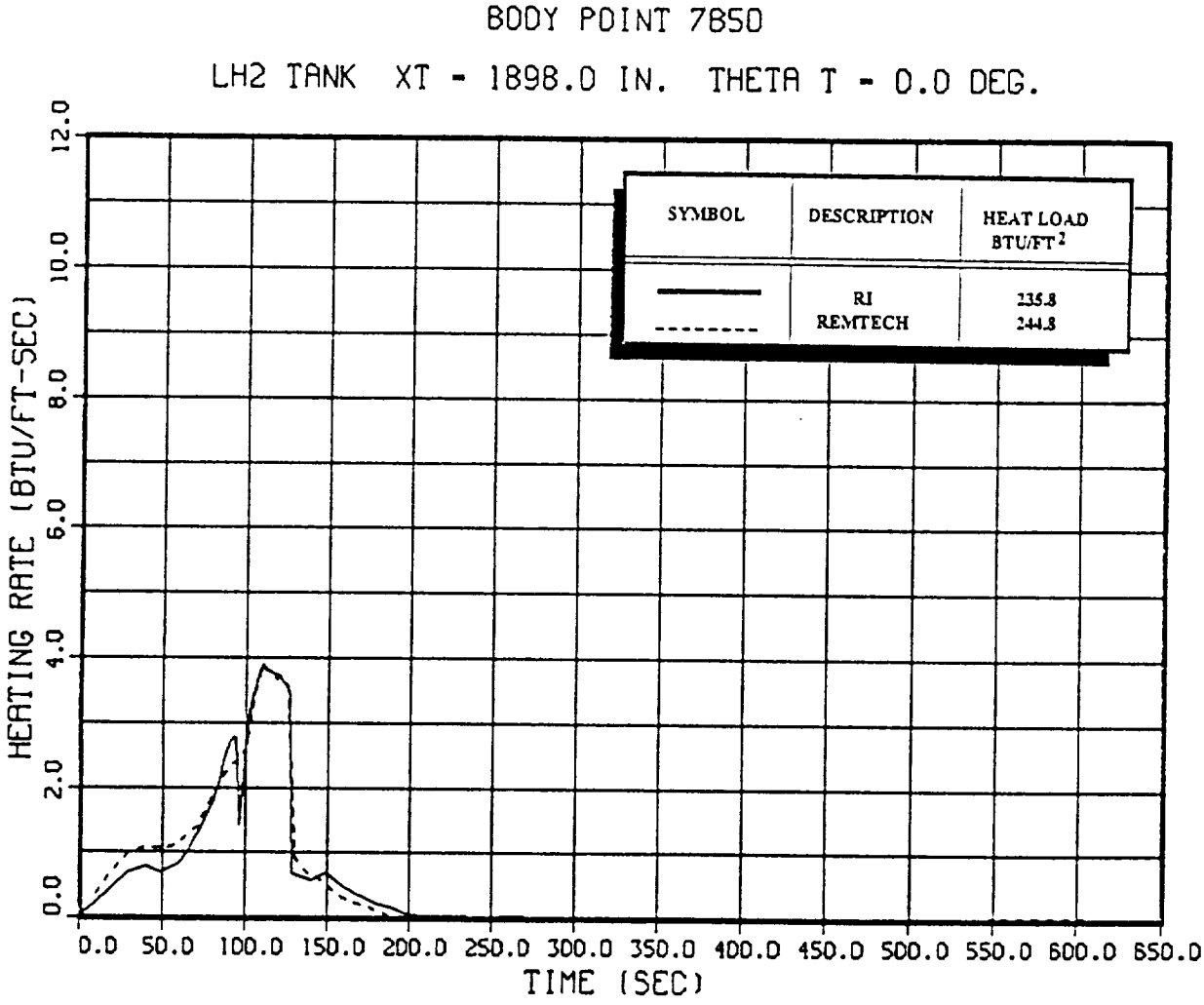

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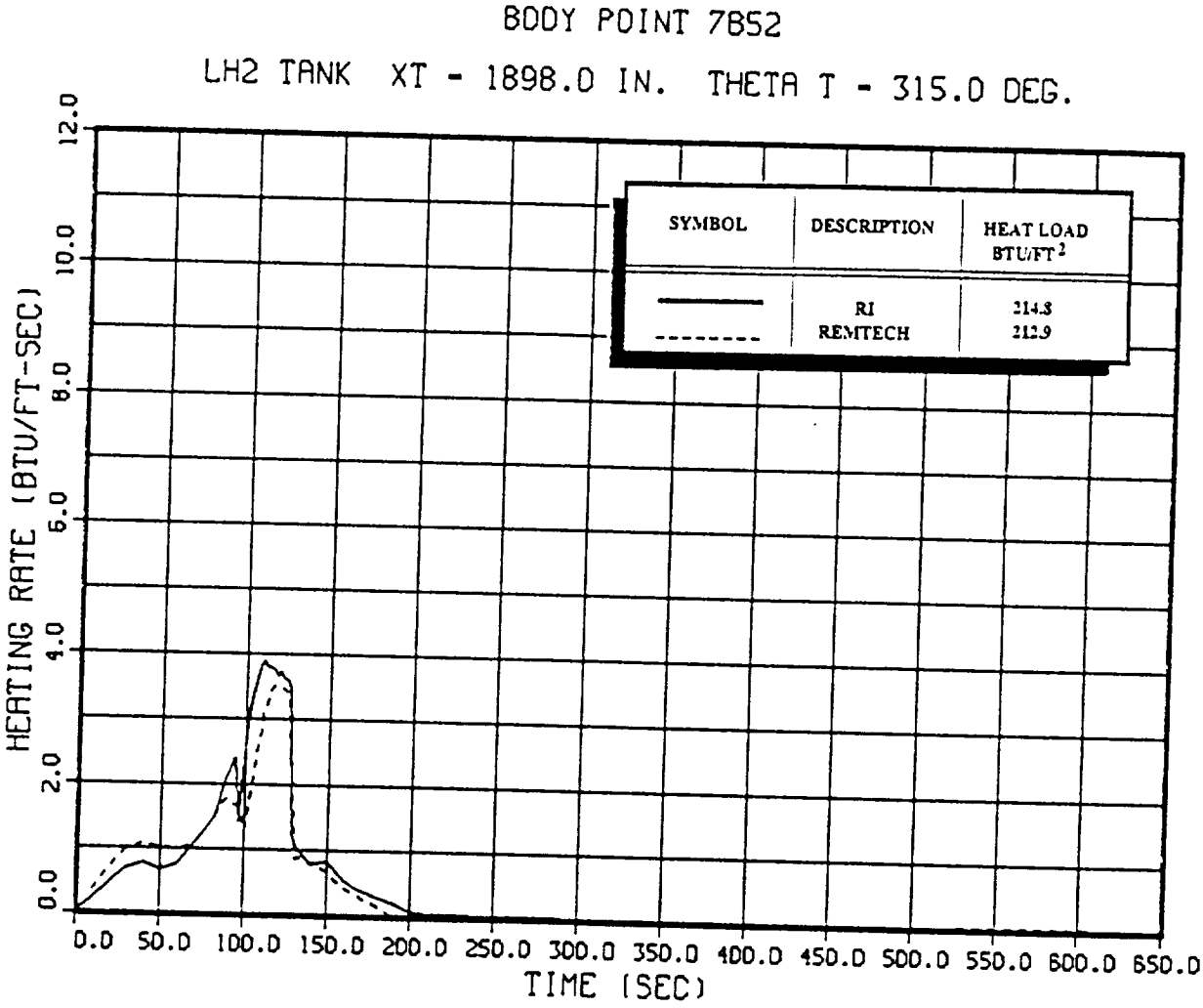

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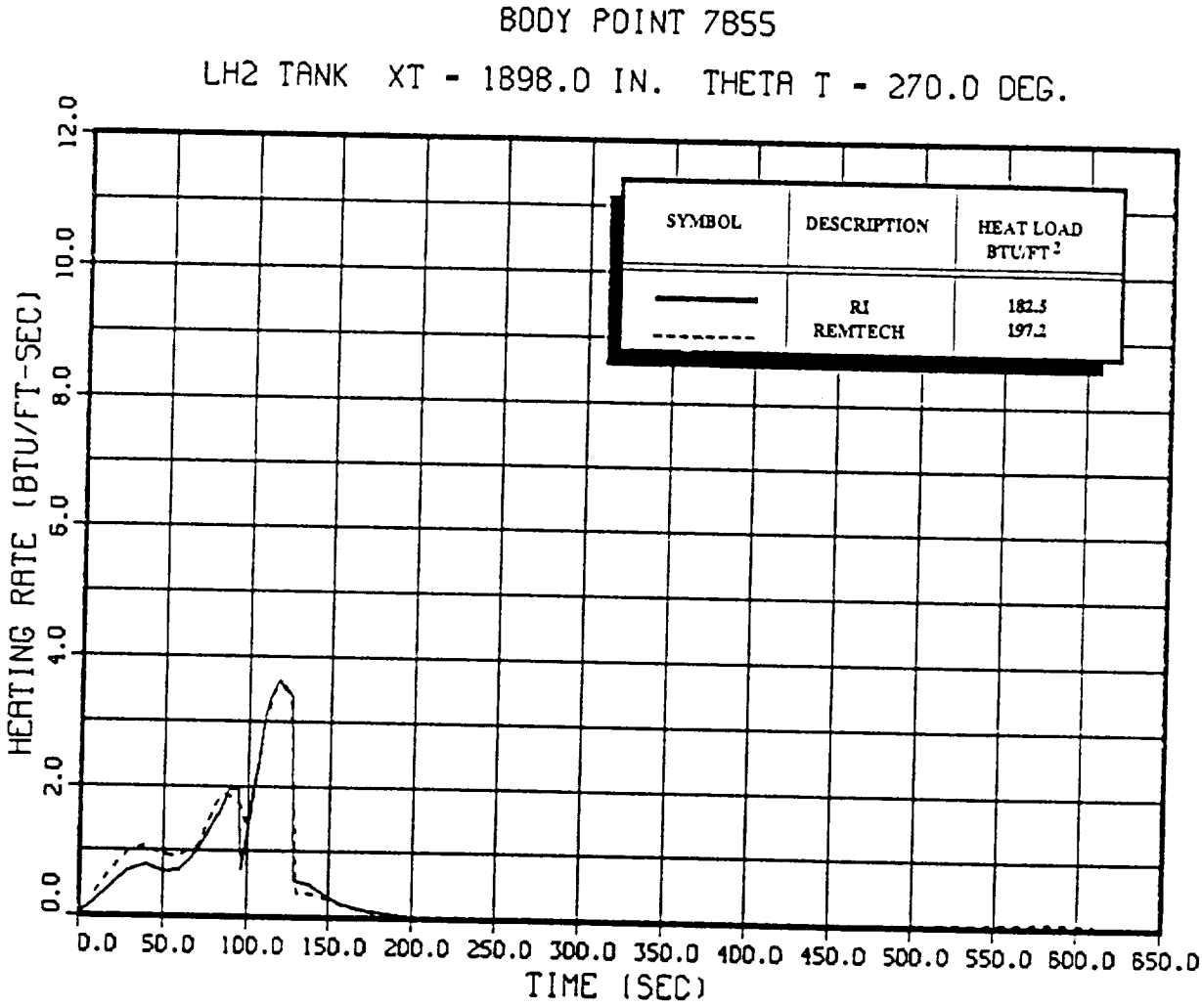

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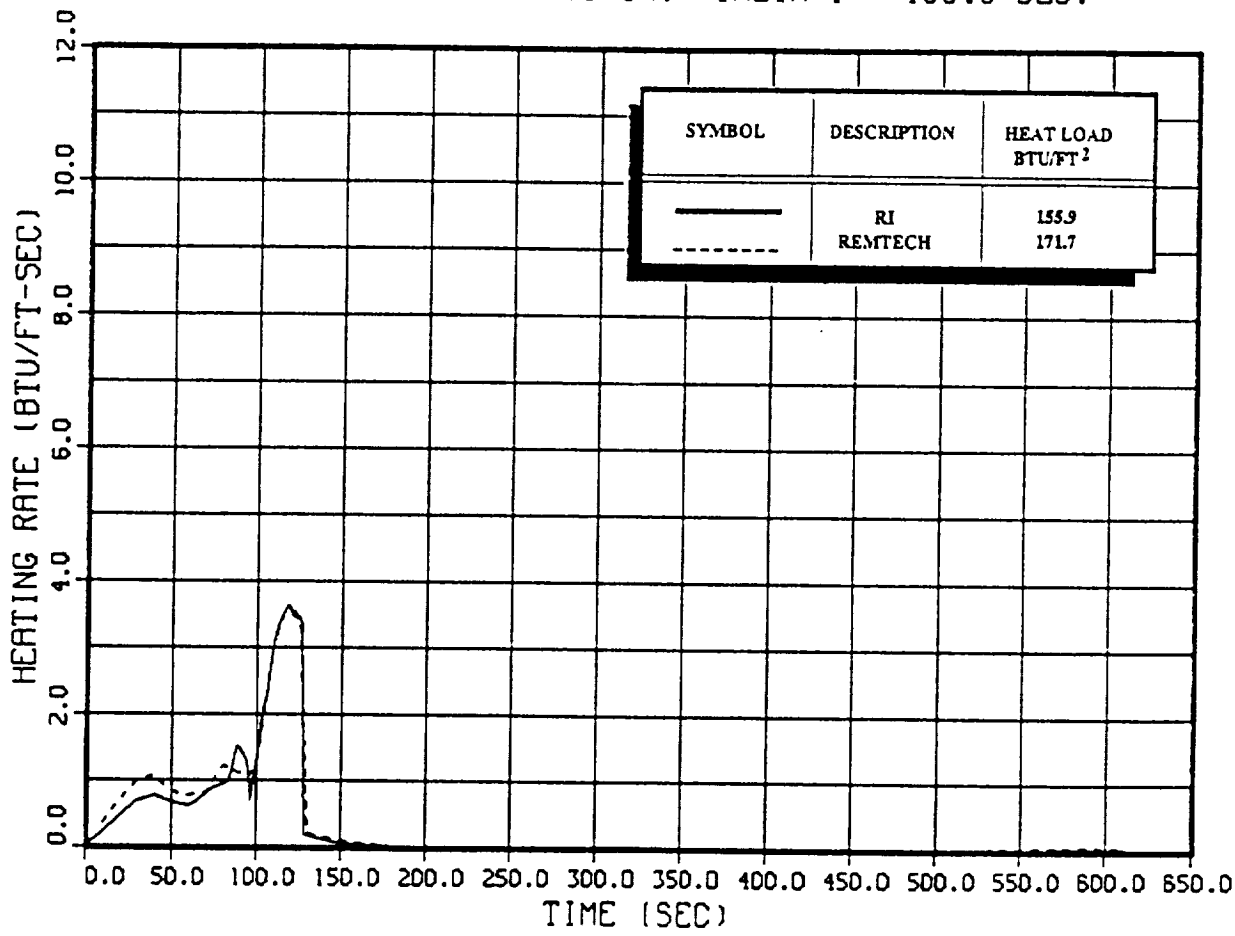

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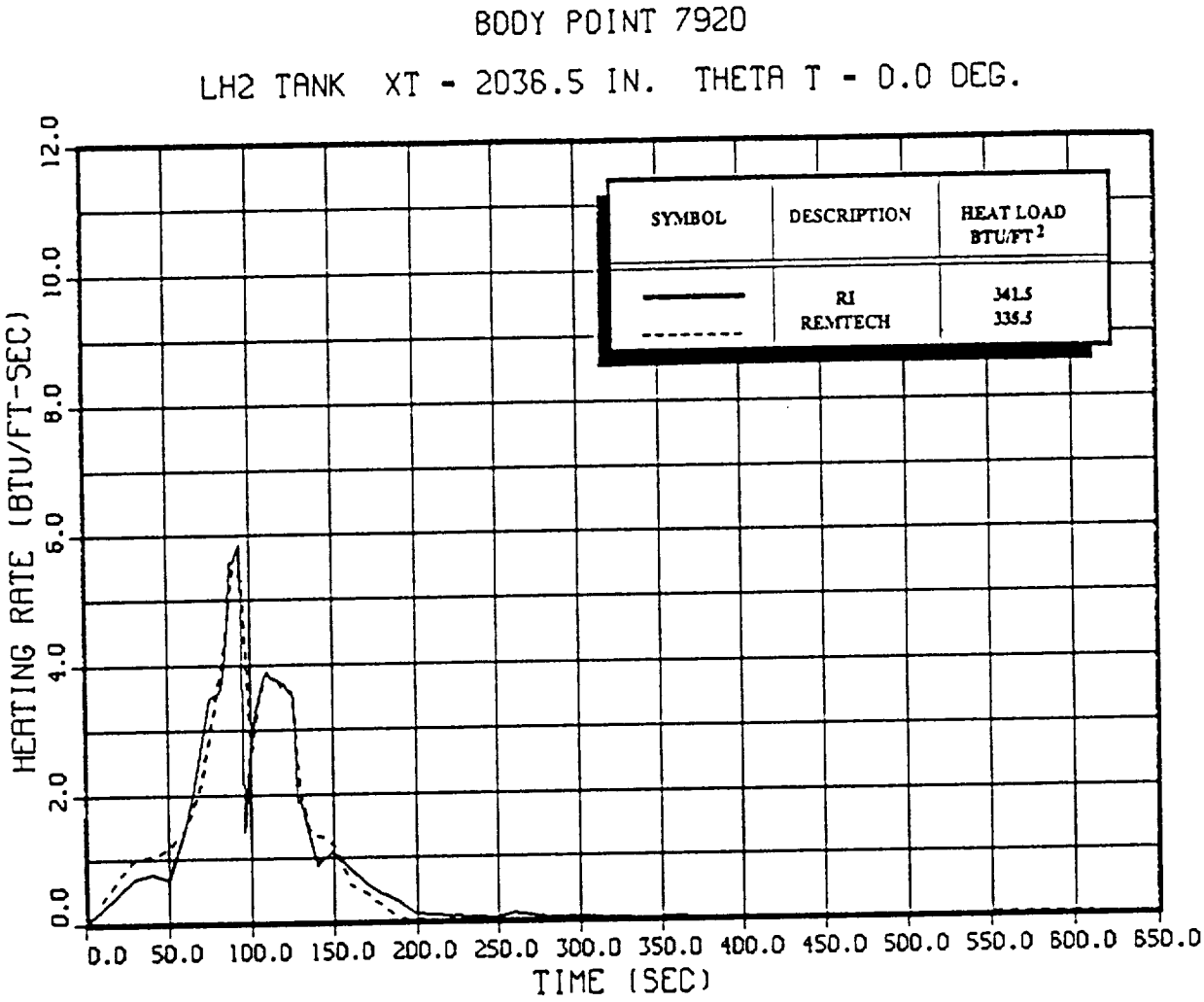

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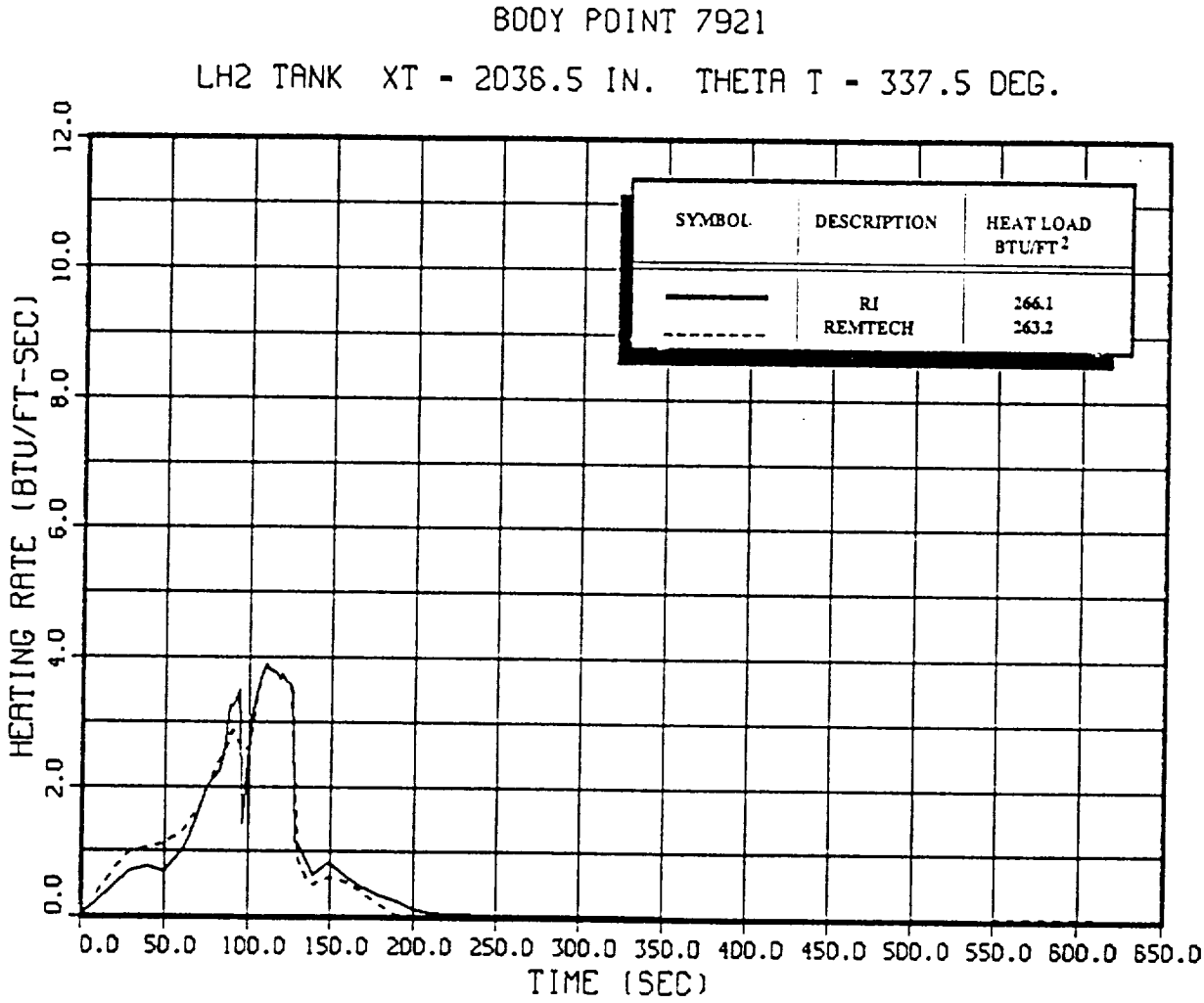

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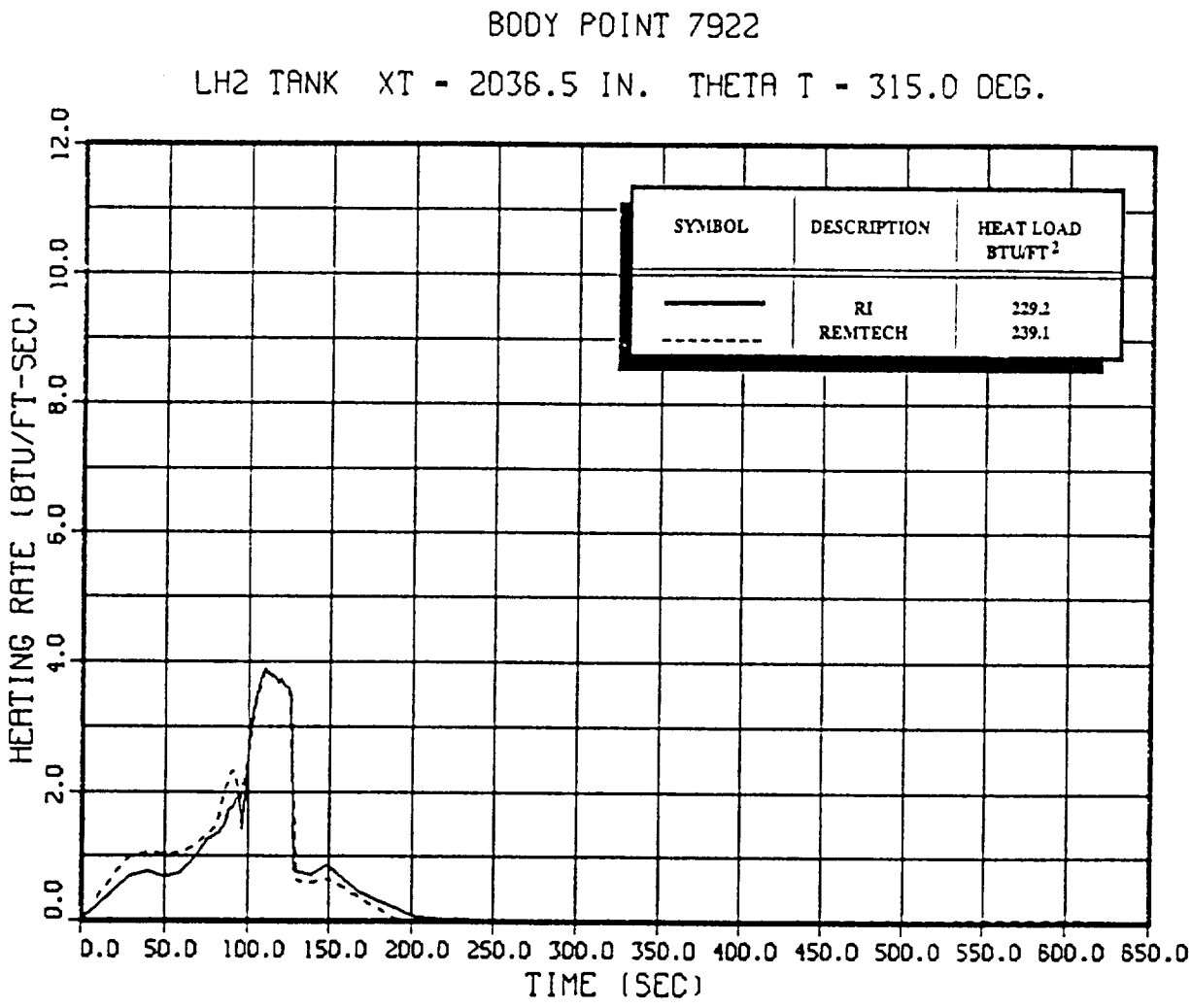

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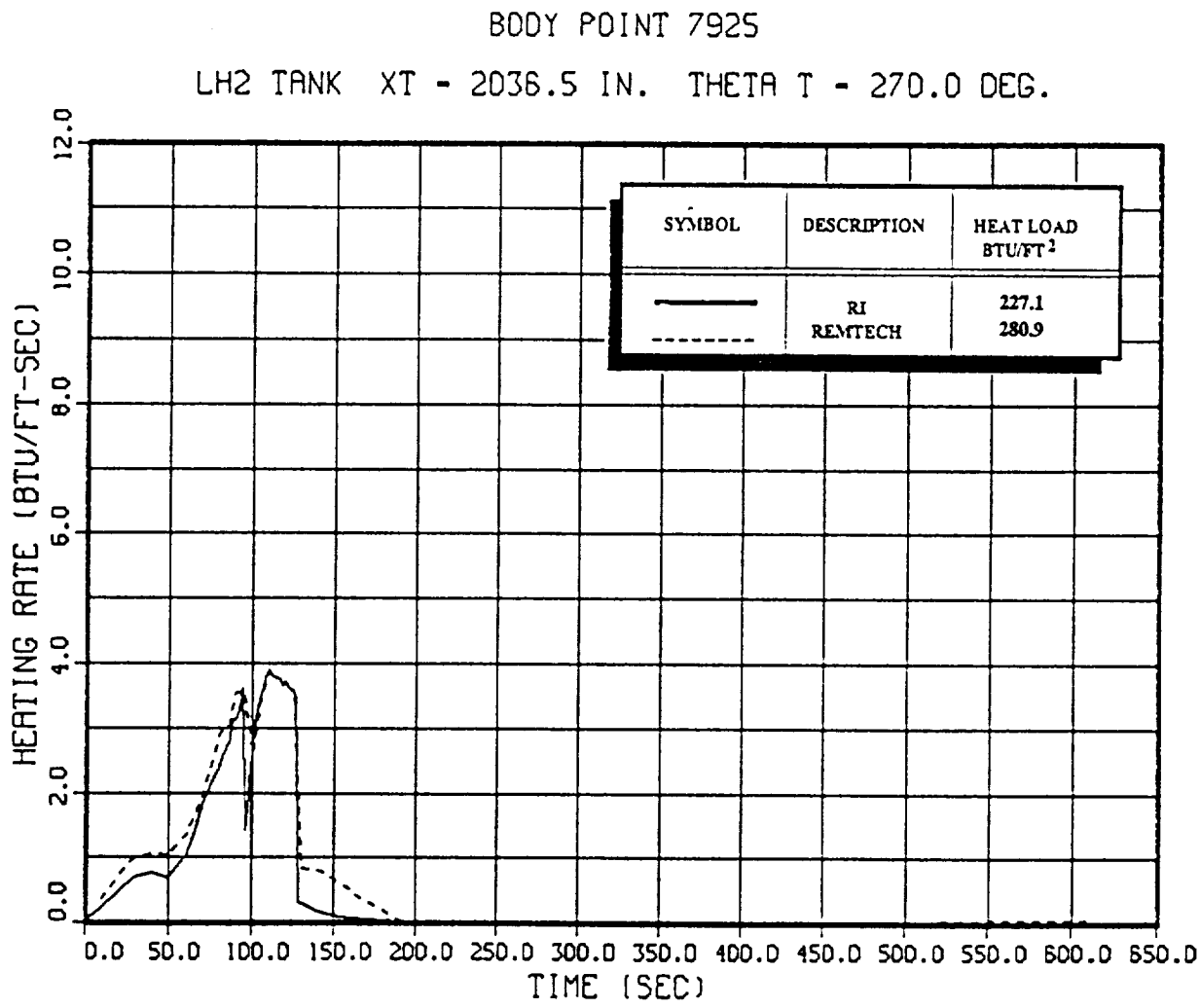

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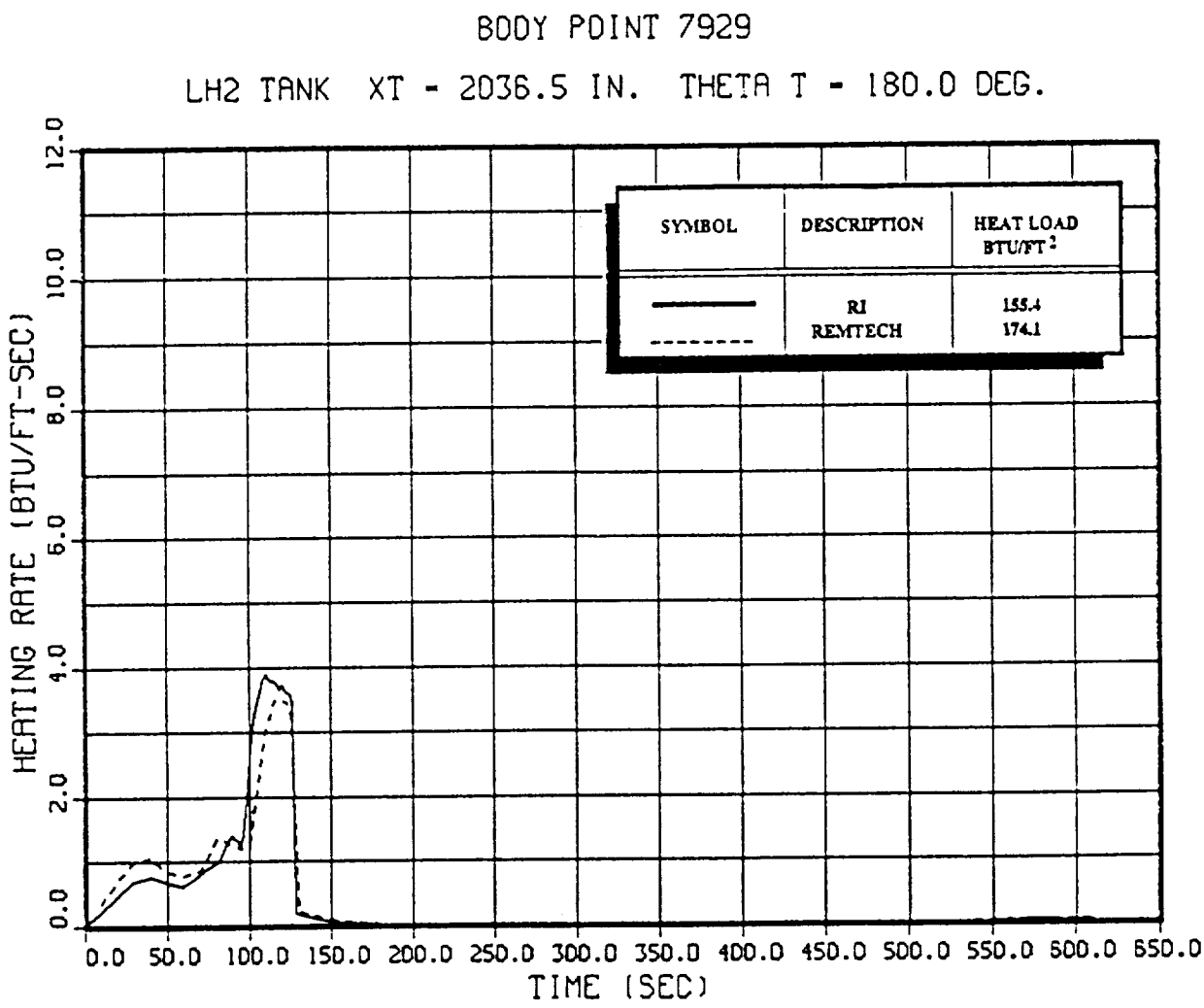
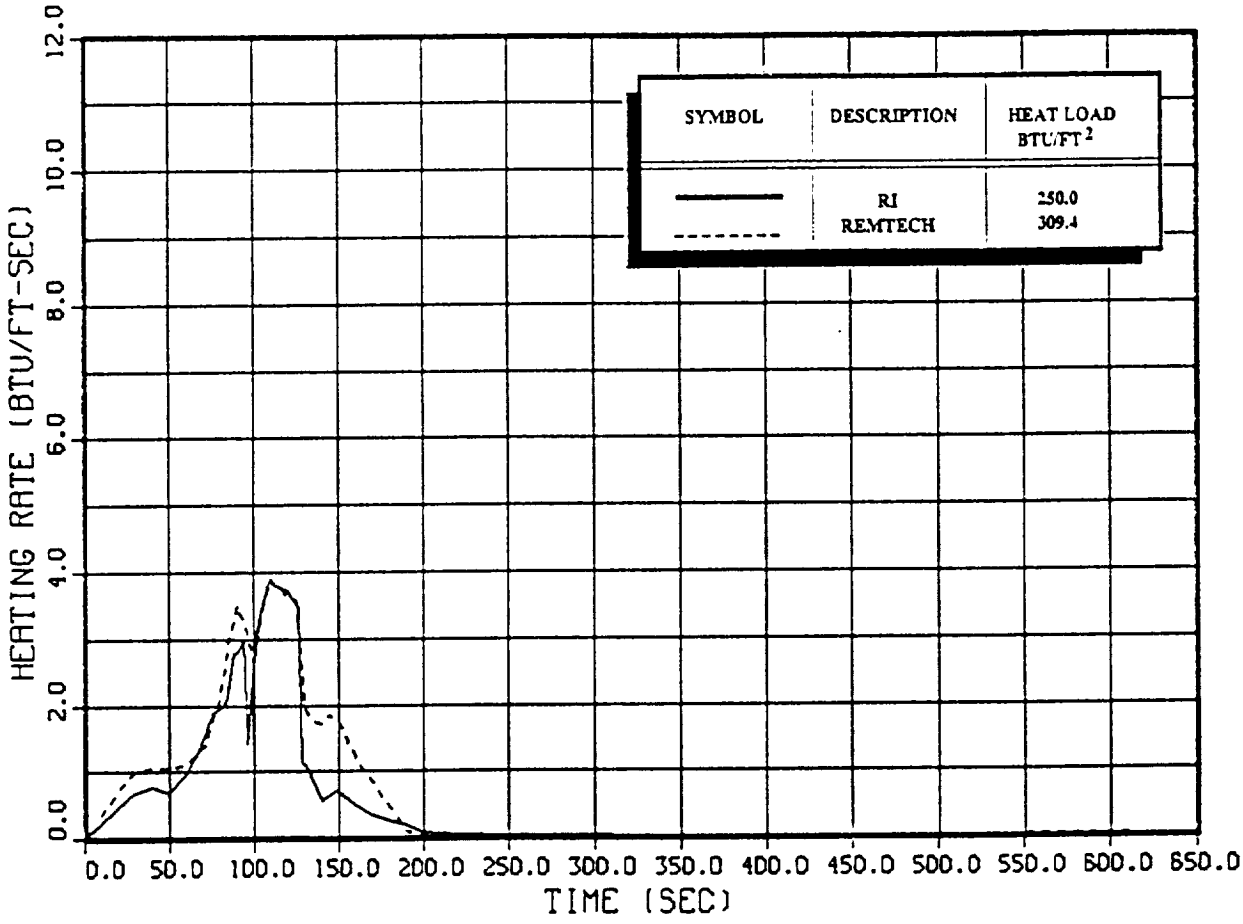


Agreement is acceptable; no TPS impact.

BODY POINT 7930

LH2 TANK XT - 2058.0 IN. THETA T - 0.0 DEG.



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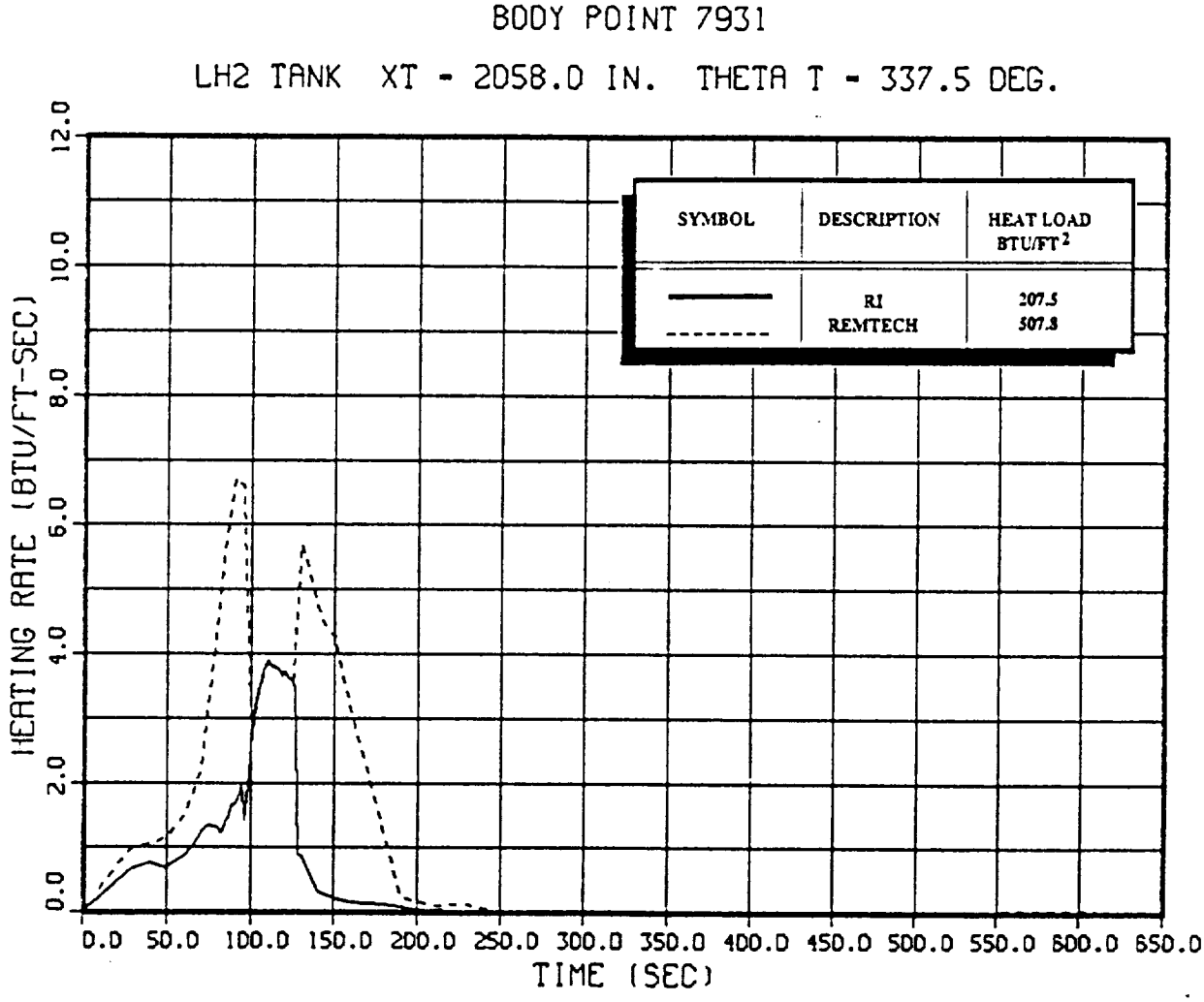
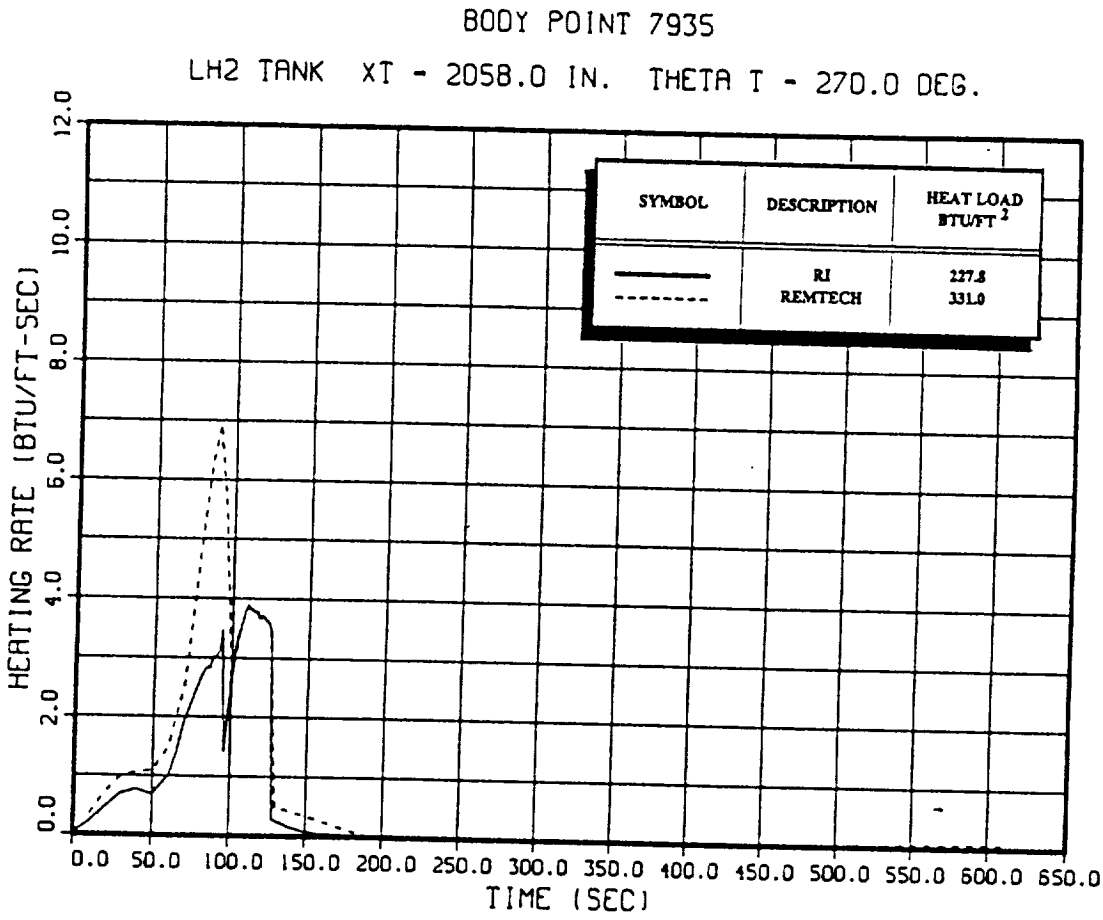
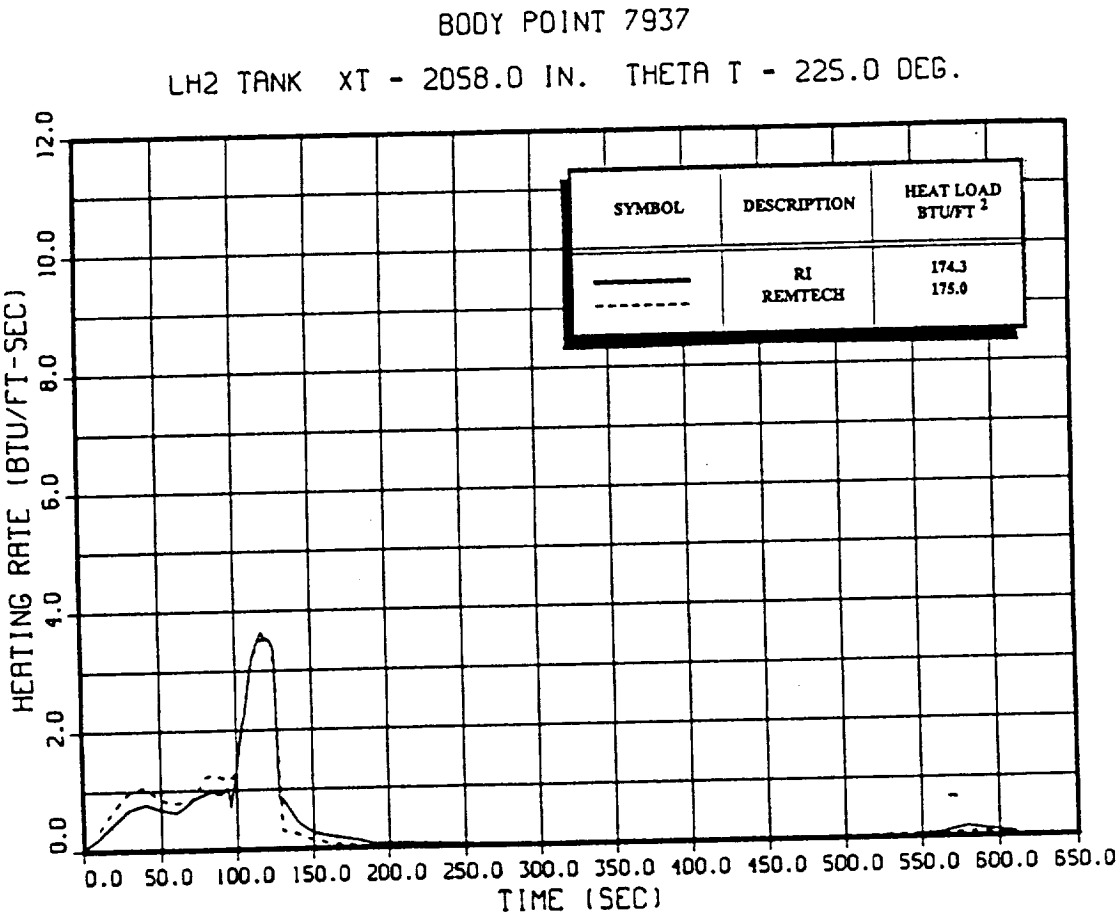


- RI IVBC-3 environment considered low. Body point 7931 is located in front of the LH2 feed line; consequently, the separation would drive the aero convection up over the clean skin acerage level. Comparison of the IVBC-3 interference factors with the IH-97 data base (T/C 5052) show that the cold wall heating rates in the environment are low.
- Possible TPS impact.



- RI IVBC-3 environment considered low. Comparison of IVBC-3 interference factors with the IH-97 data base (T/C 5051) show that the cold wall heating rates are low in the $M_\infty = 3$ range.
- Possible TPS impact.



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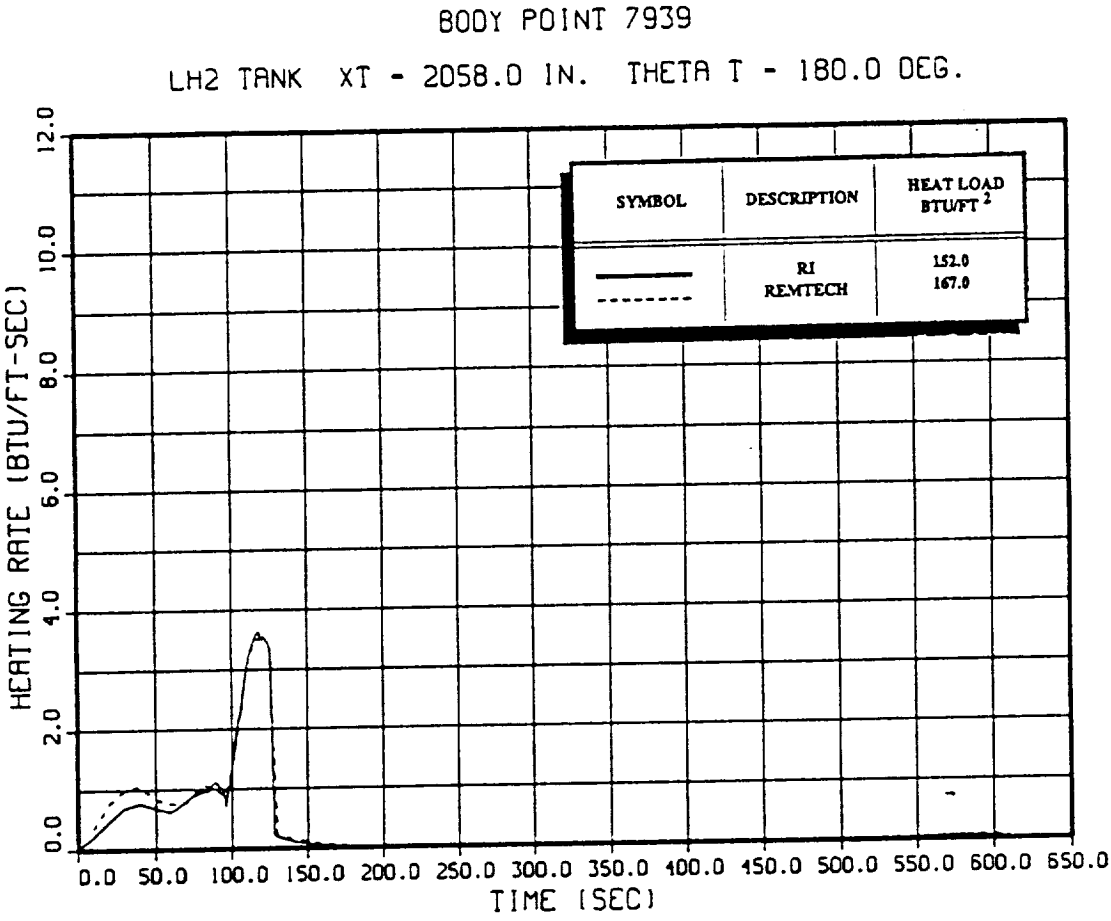

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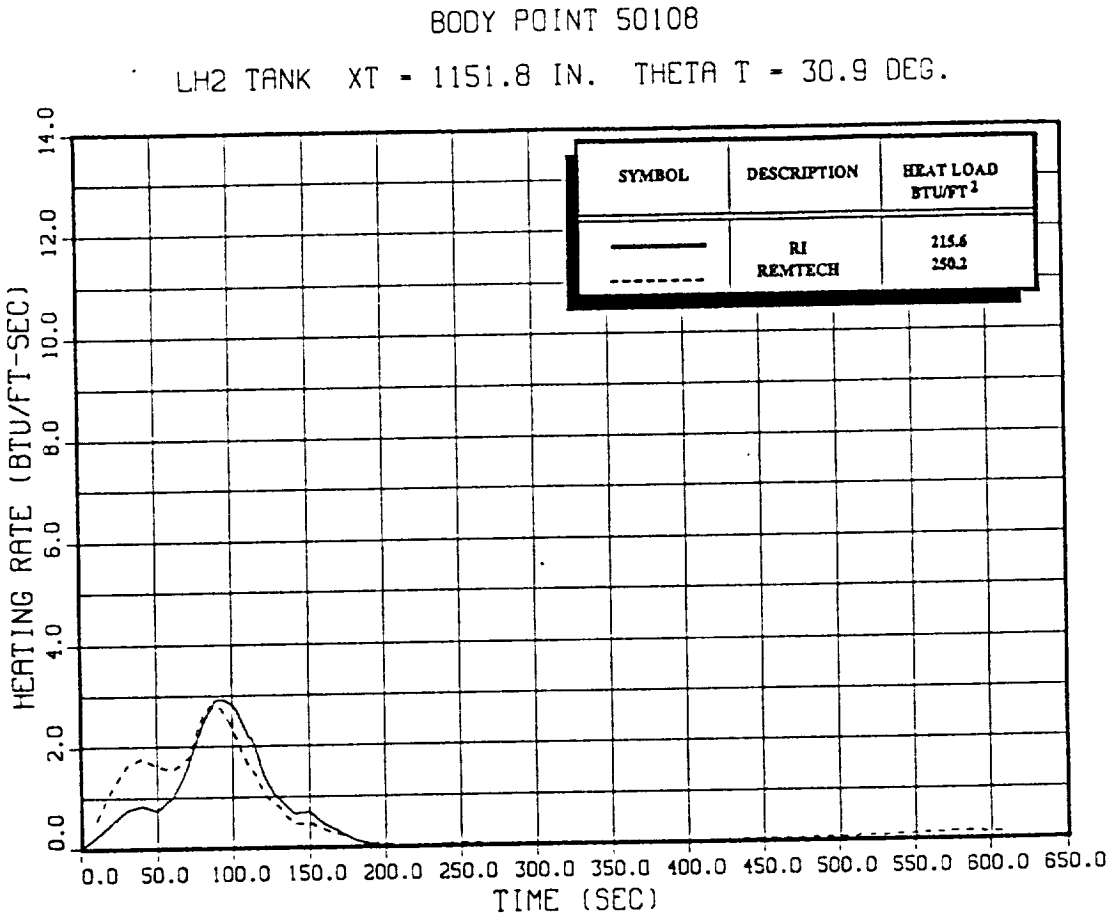

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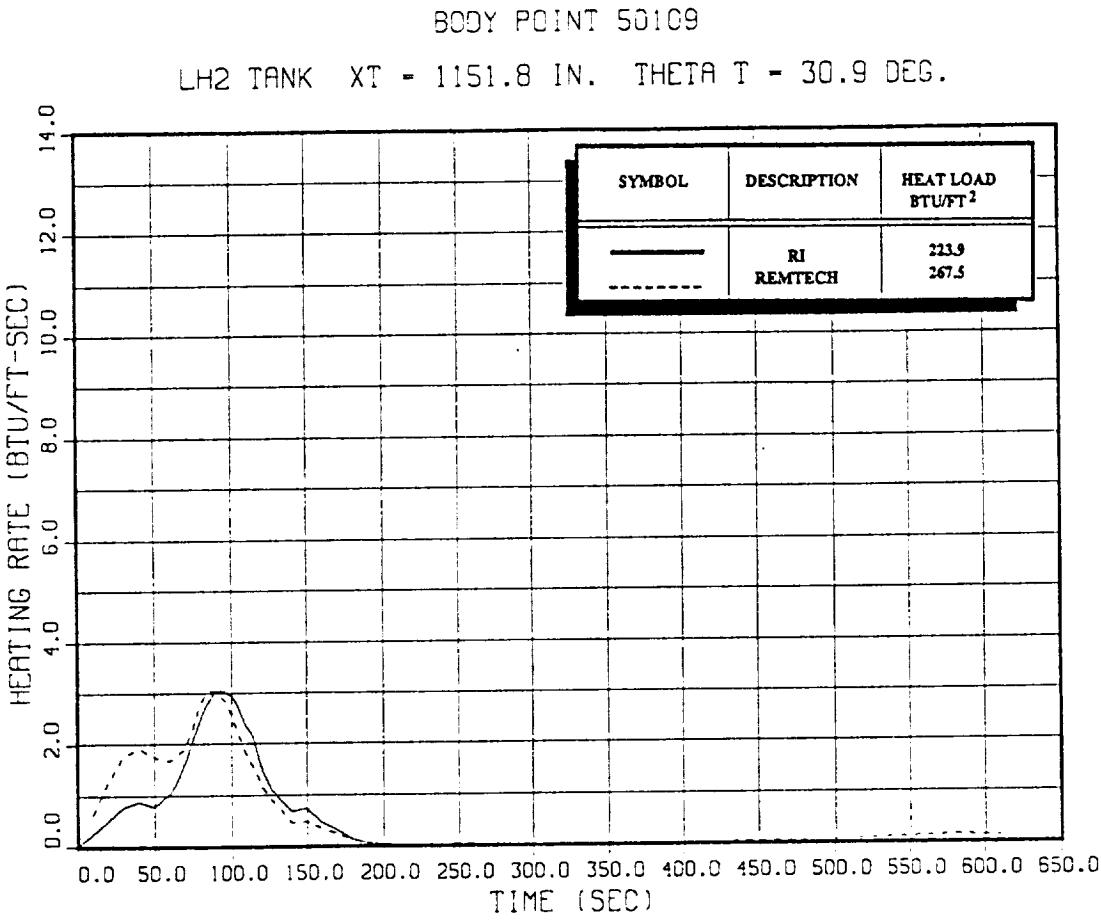
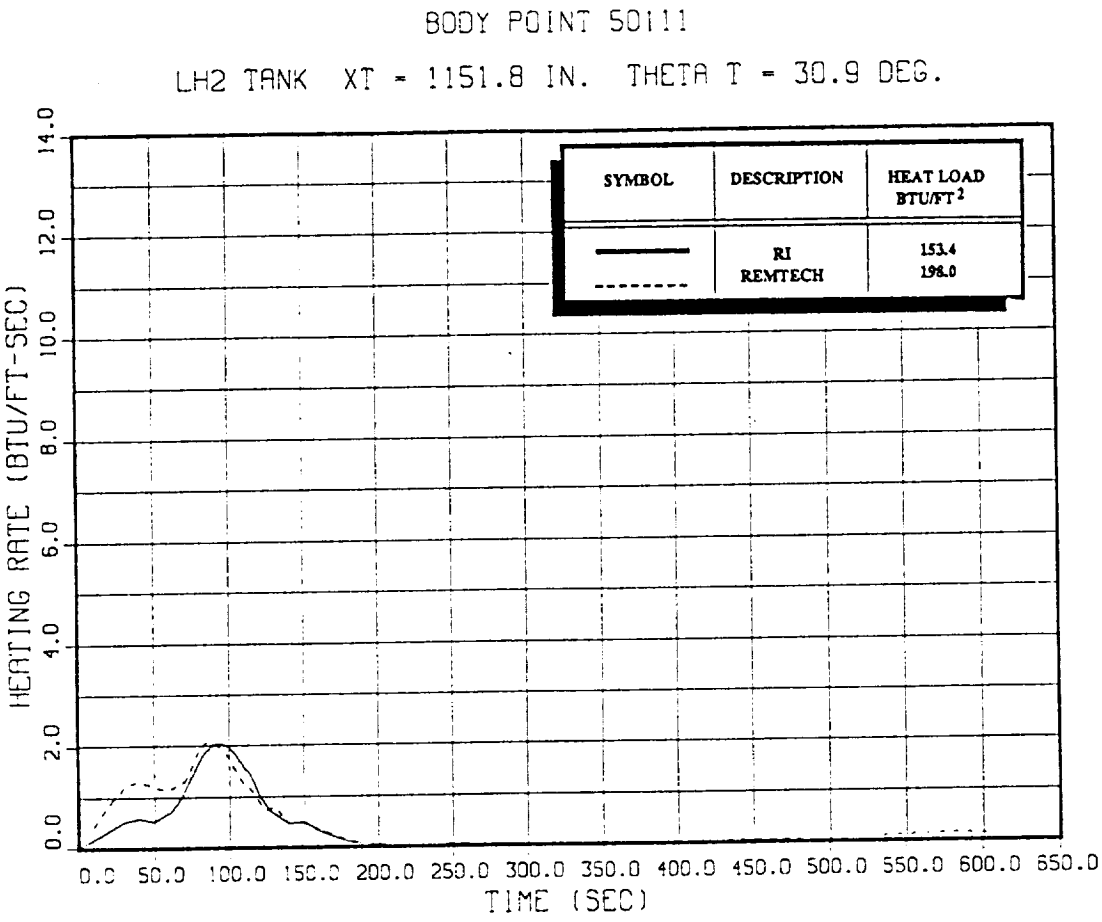


Agreement is acceptable; no TPS impact.



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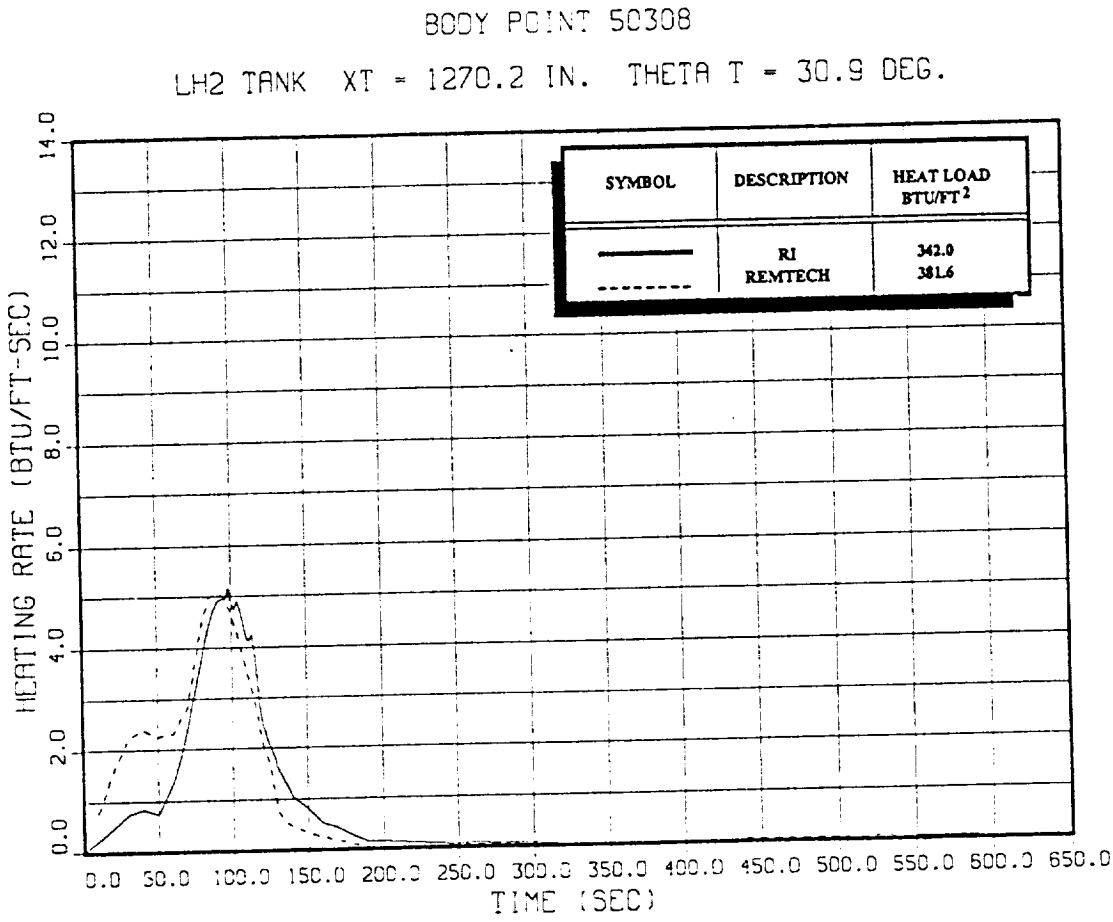

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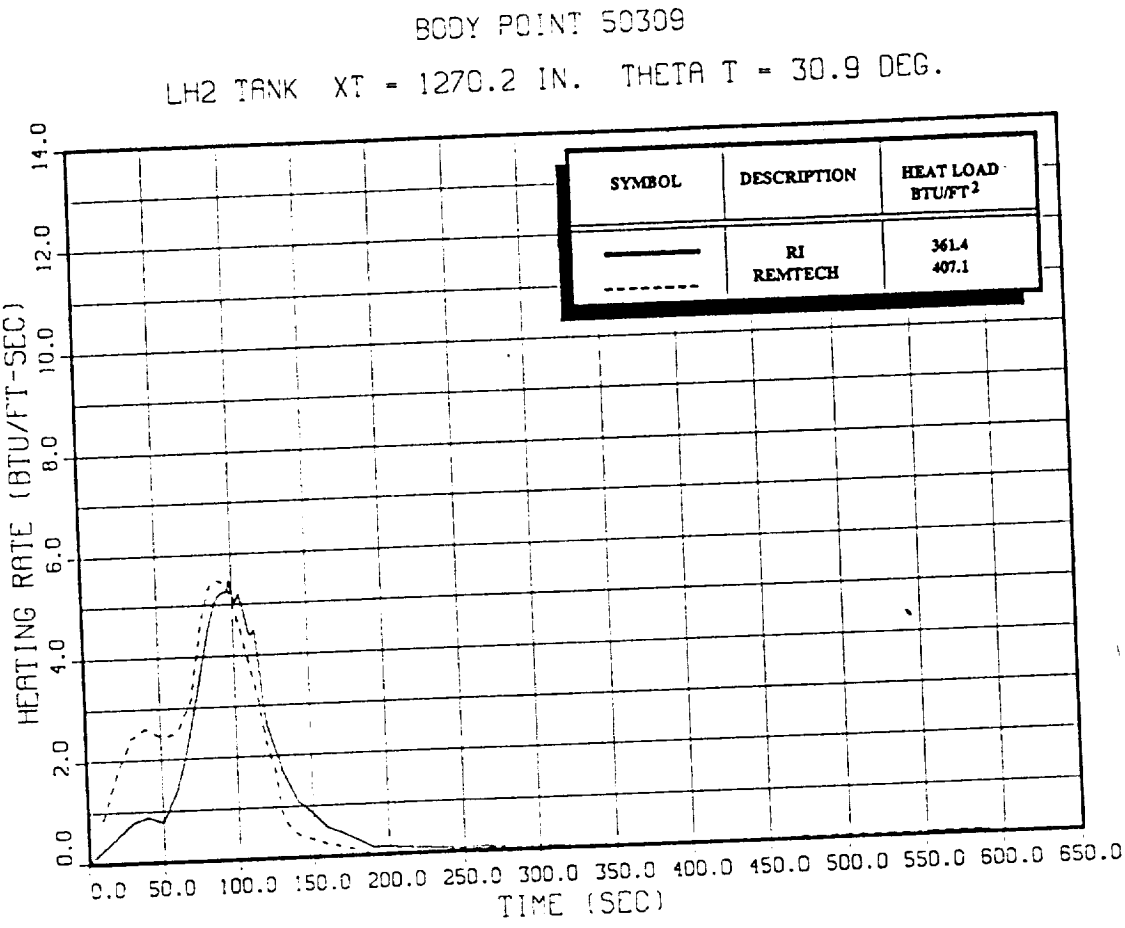

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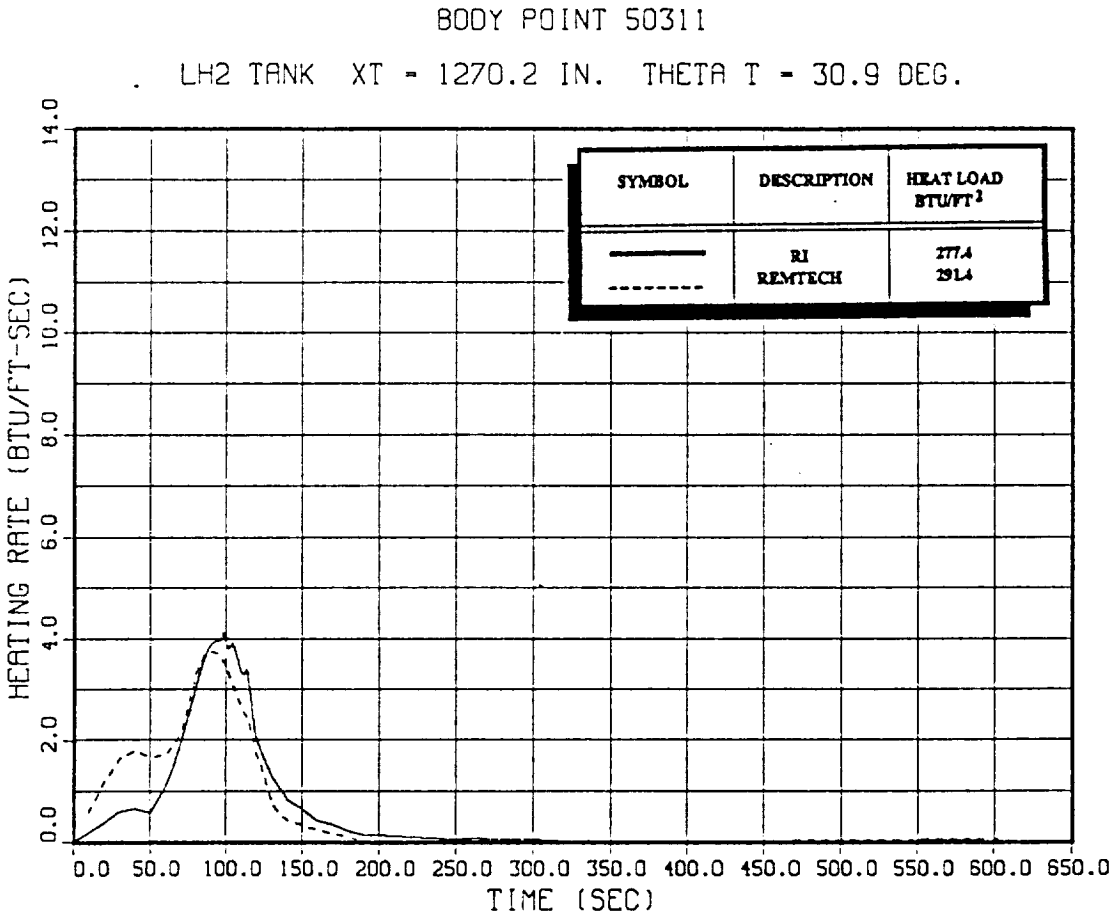

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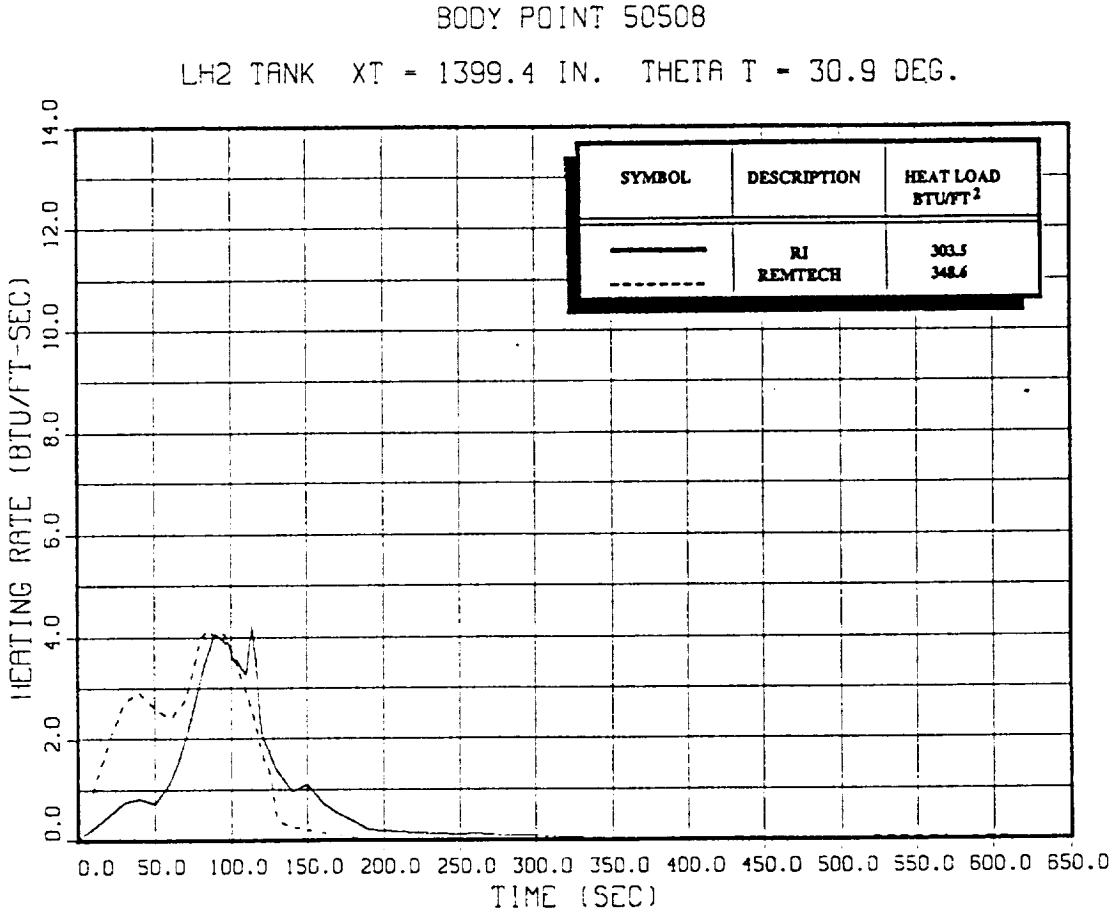

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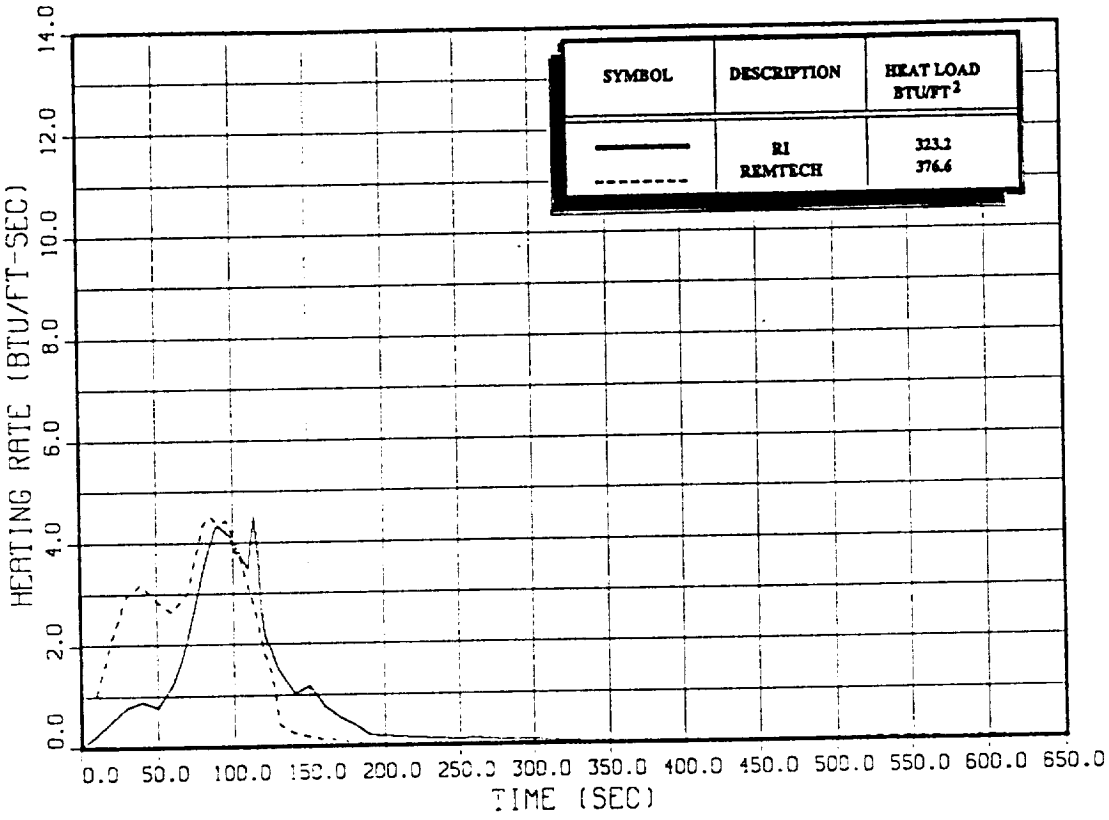
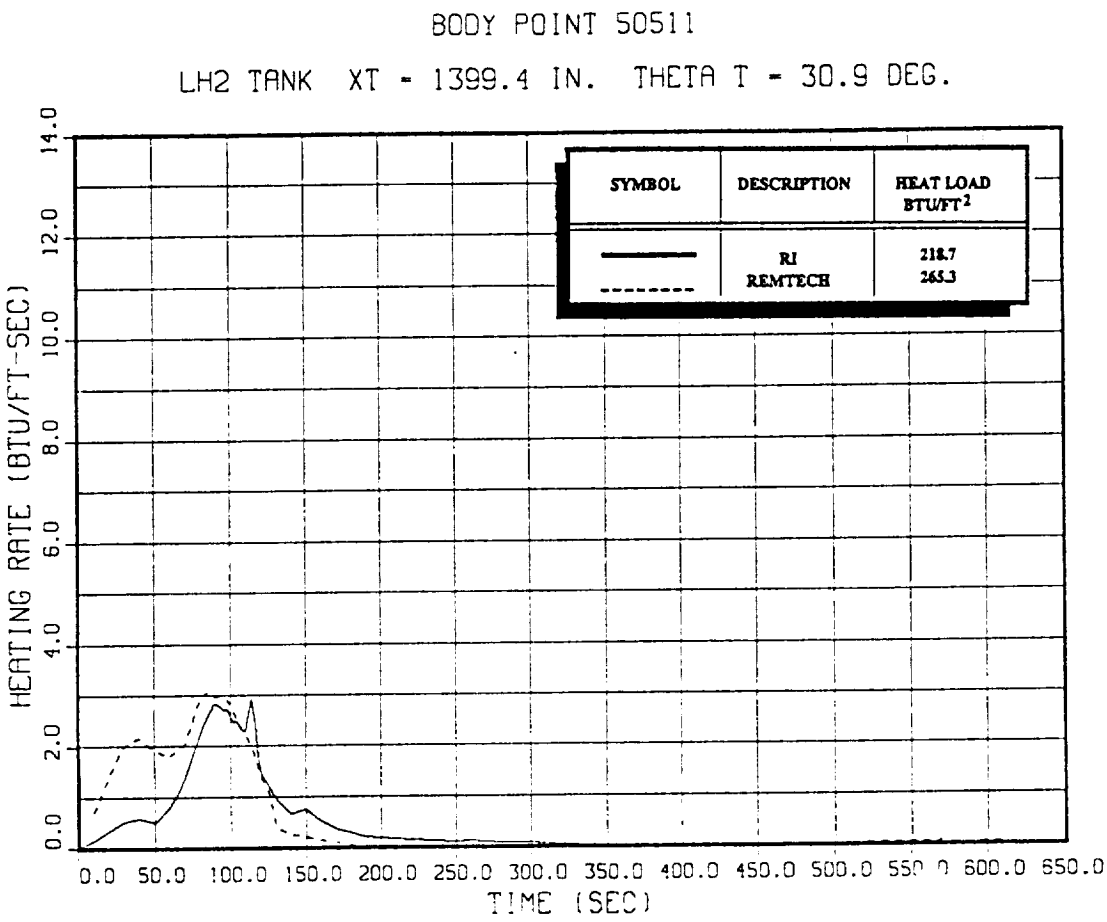
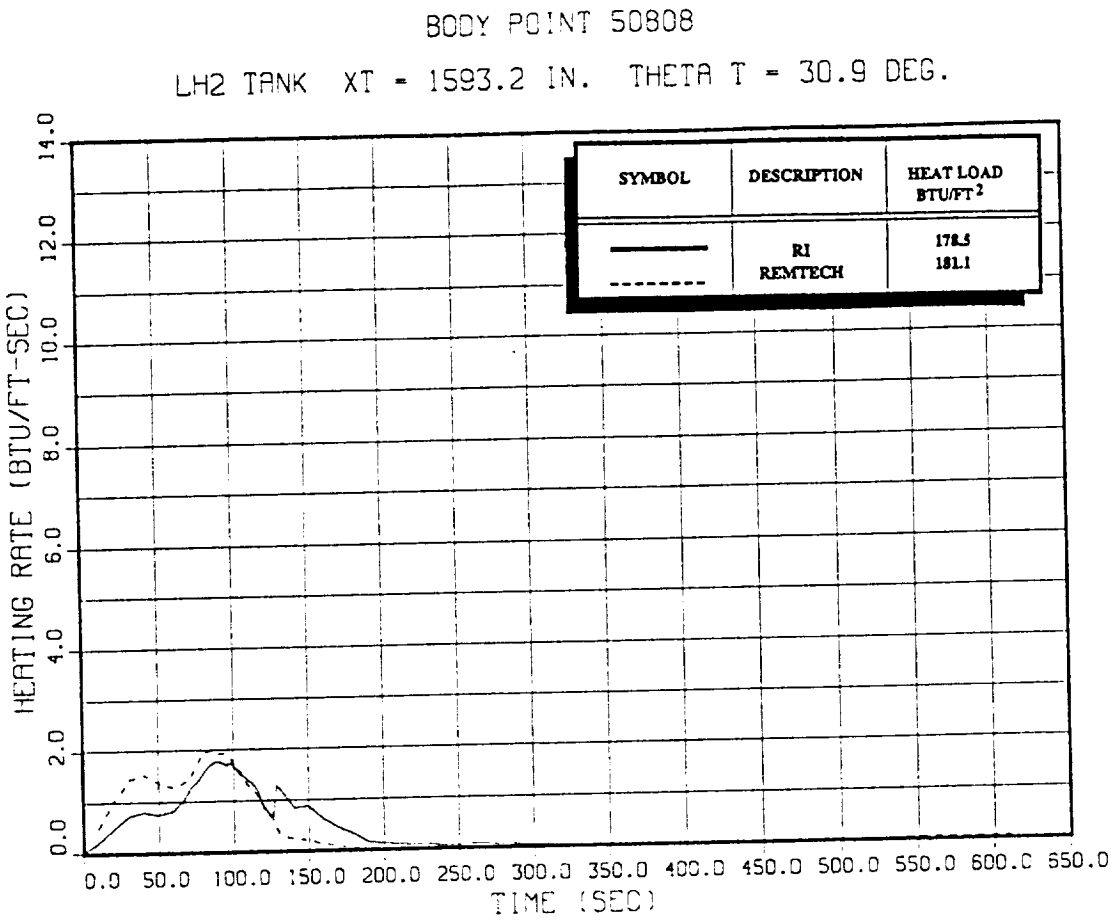


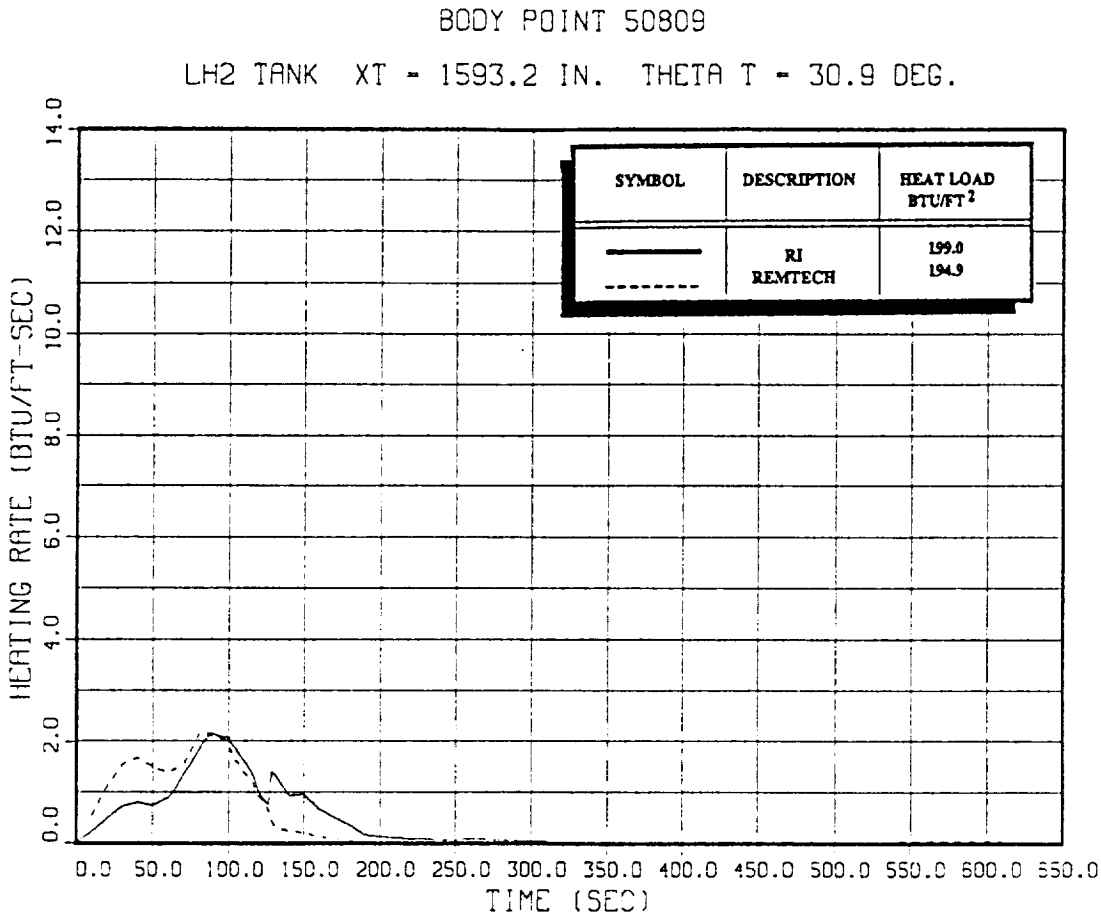
Agreement is acceptable; no TPS impact.



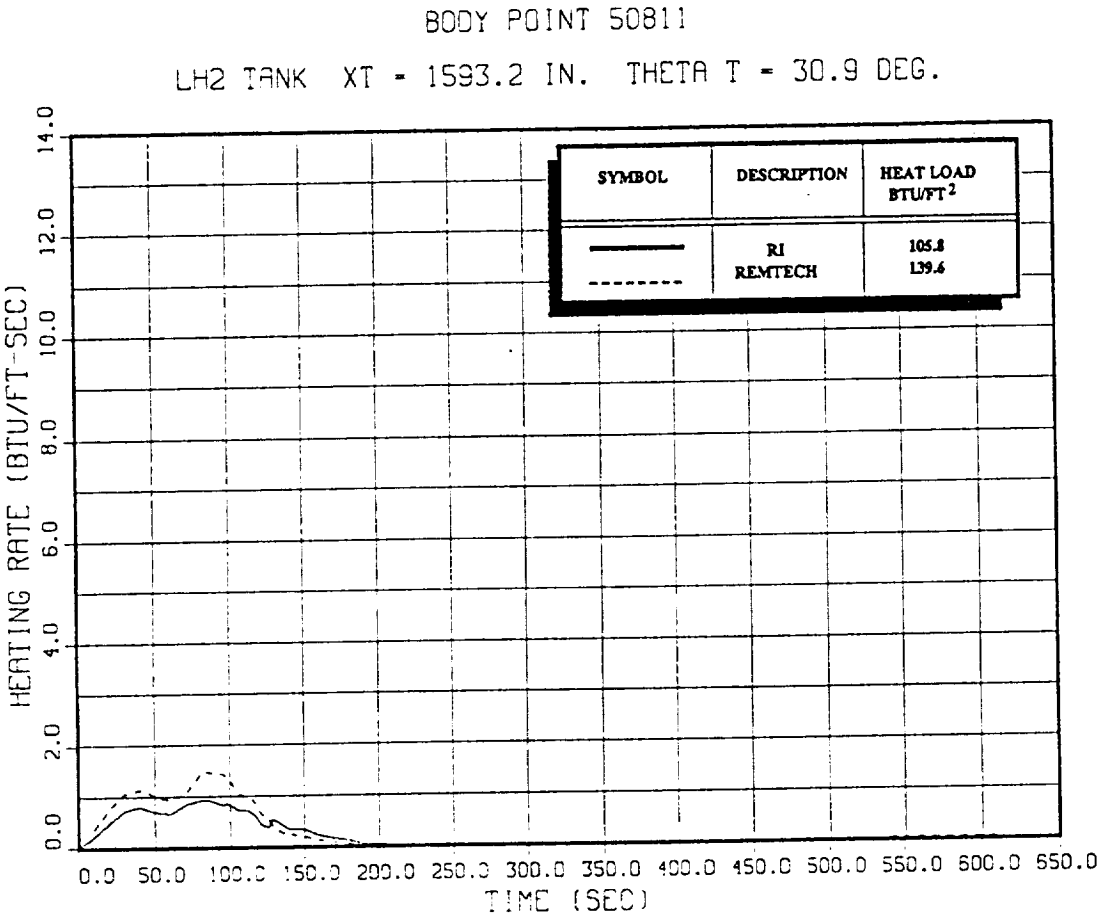
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.



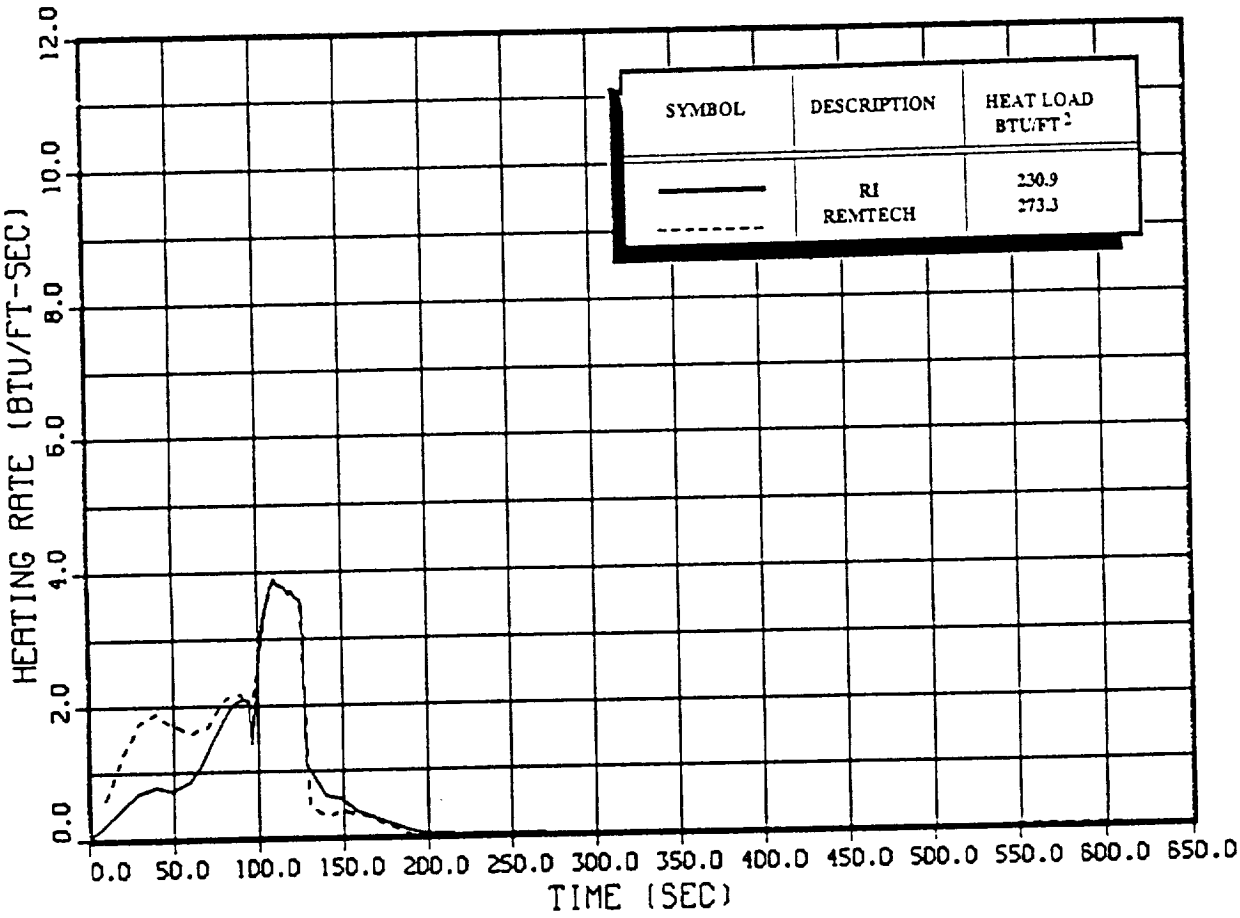
Agreement is acceptable; no TPS impact.



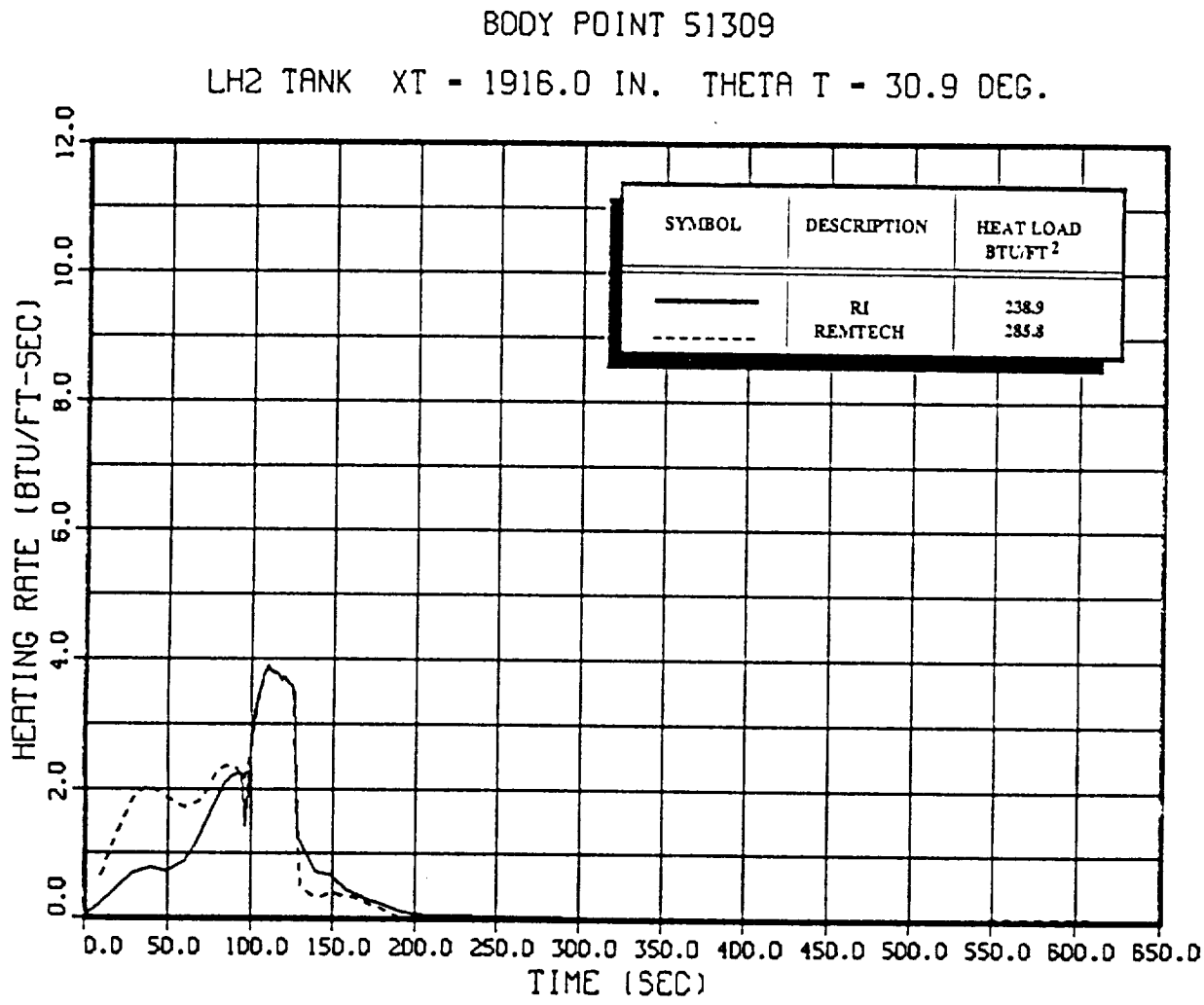
Agreement is acceptable; no TPS impact.

BODY POINT 51308

LH2 TANK XT - 1916.0 IN. THETA T - 30.9 DEG.



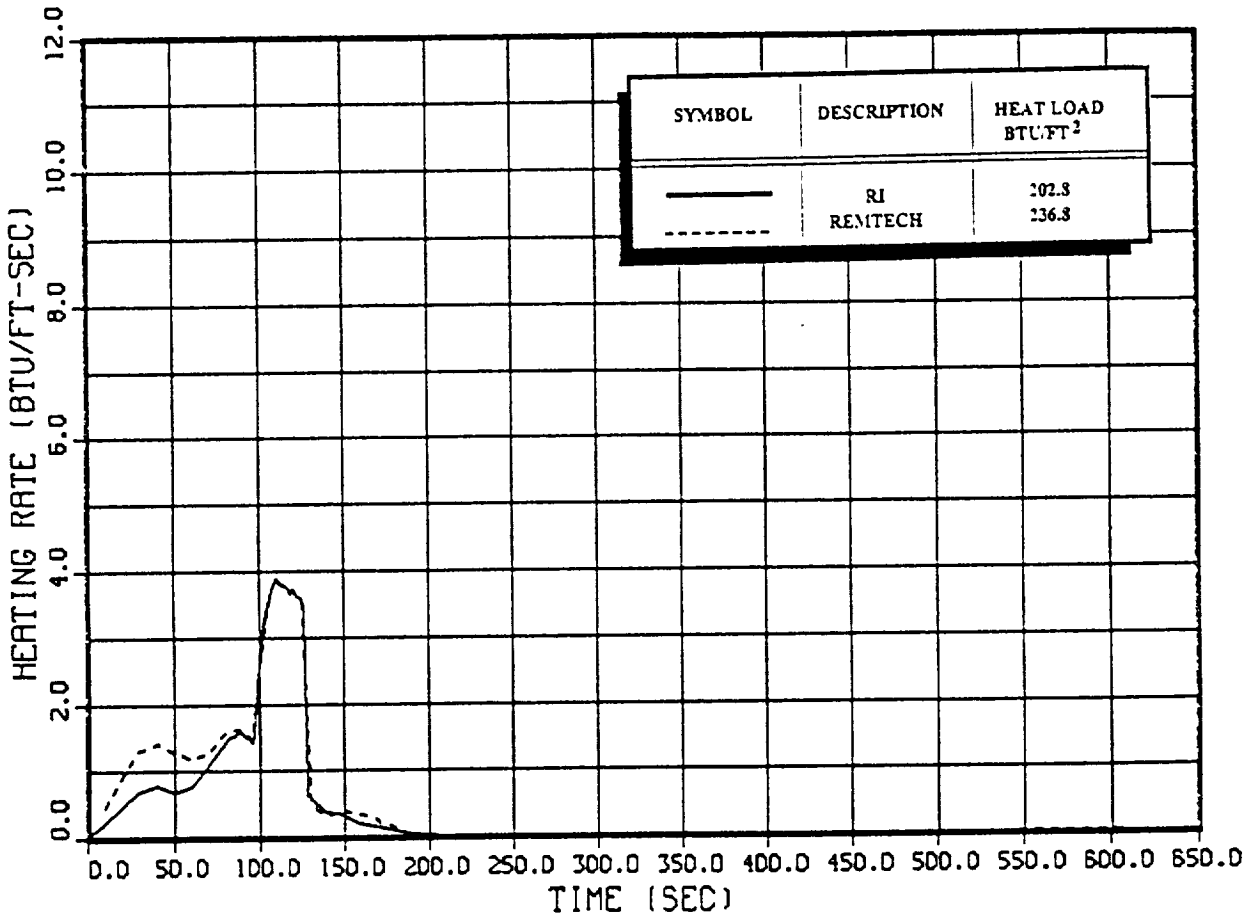
Agreement is acceptable; no TPS impact.



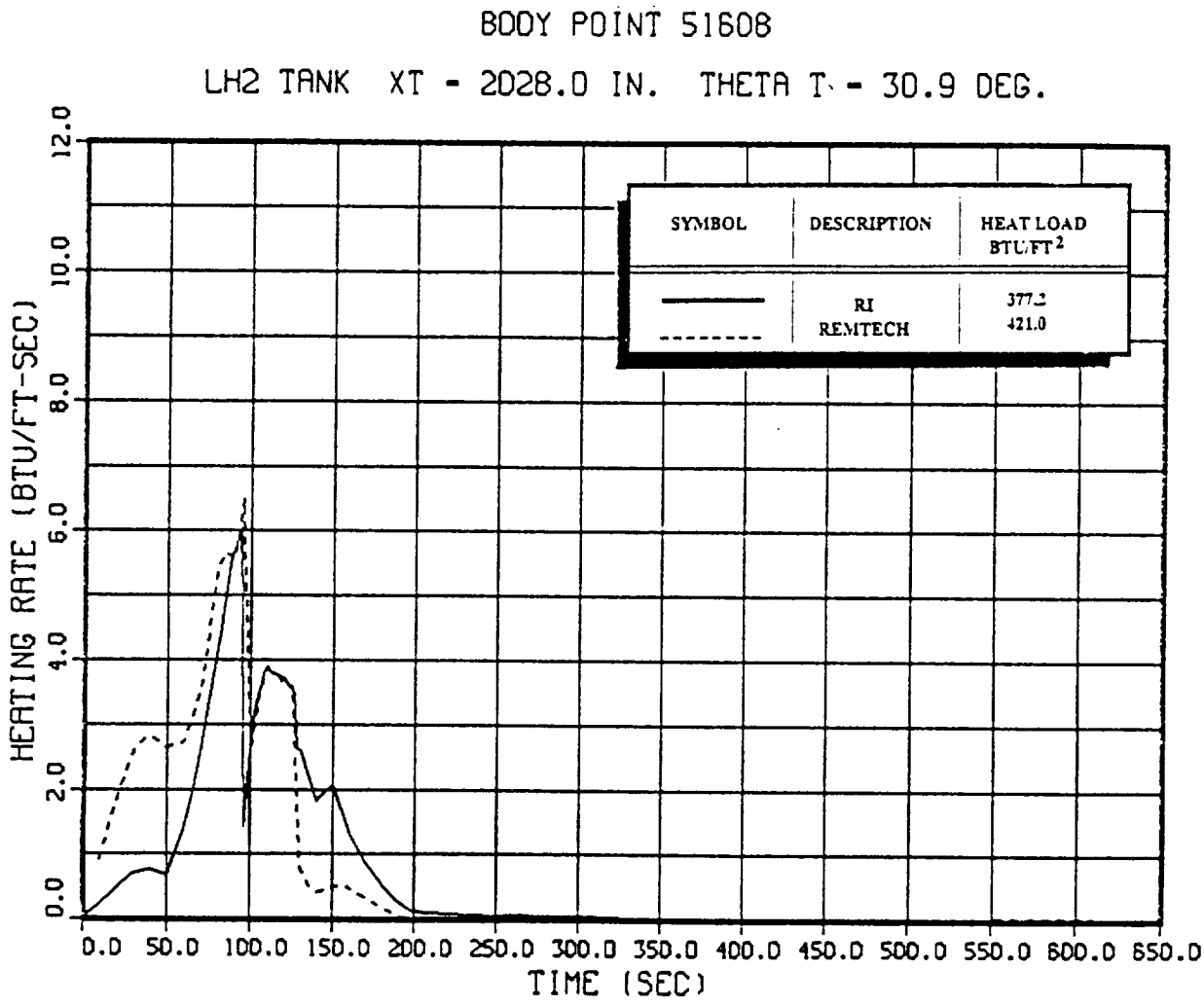
Agreement is acceptable; no TPS impact.

BODY POINT 51311

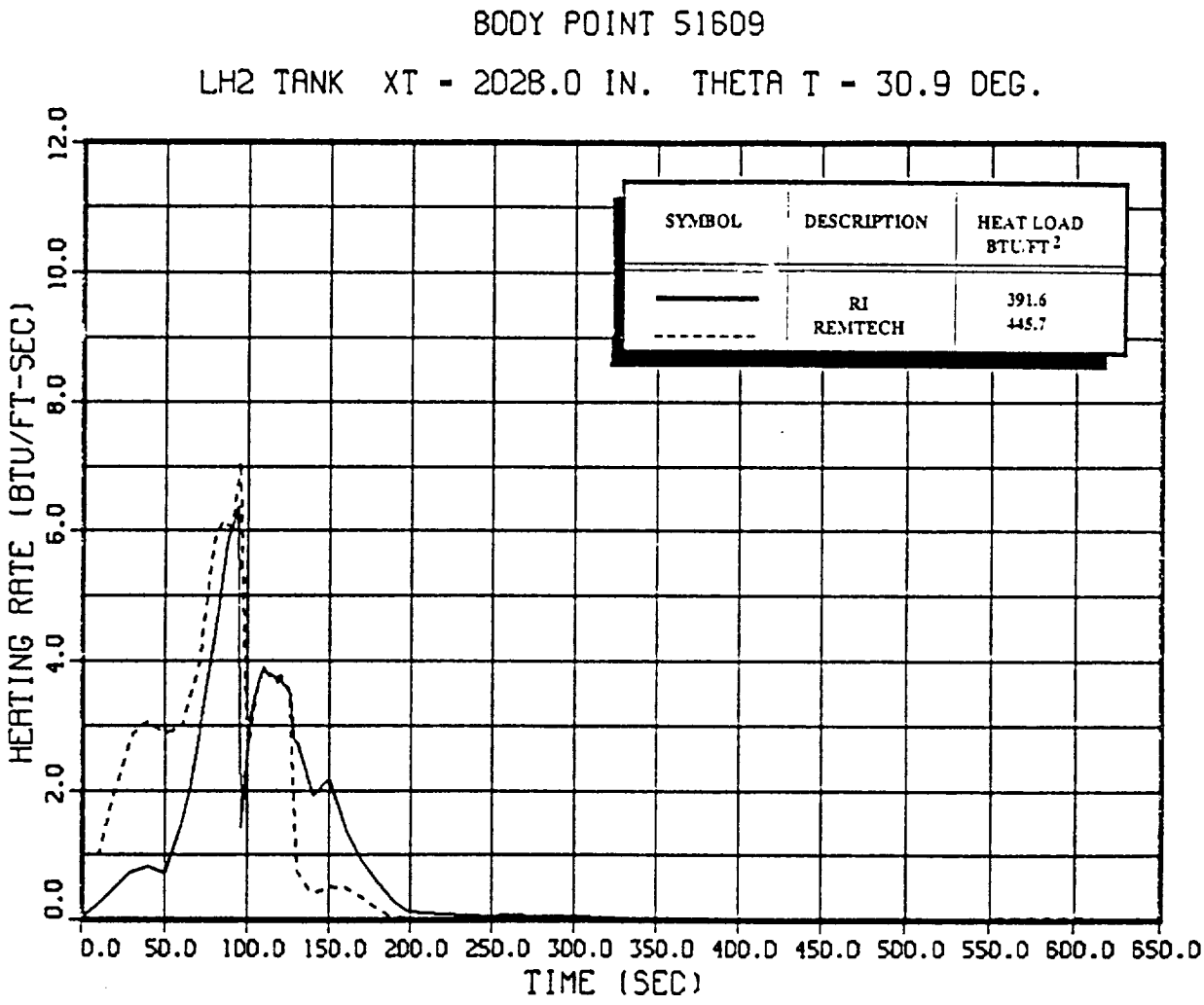
LH2 TANK XT - 1916.0 IN. THETA T - 30.9 DEG.



Agreement is acceptable; no TPS impact.



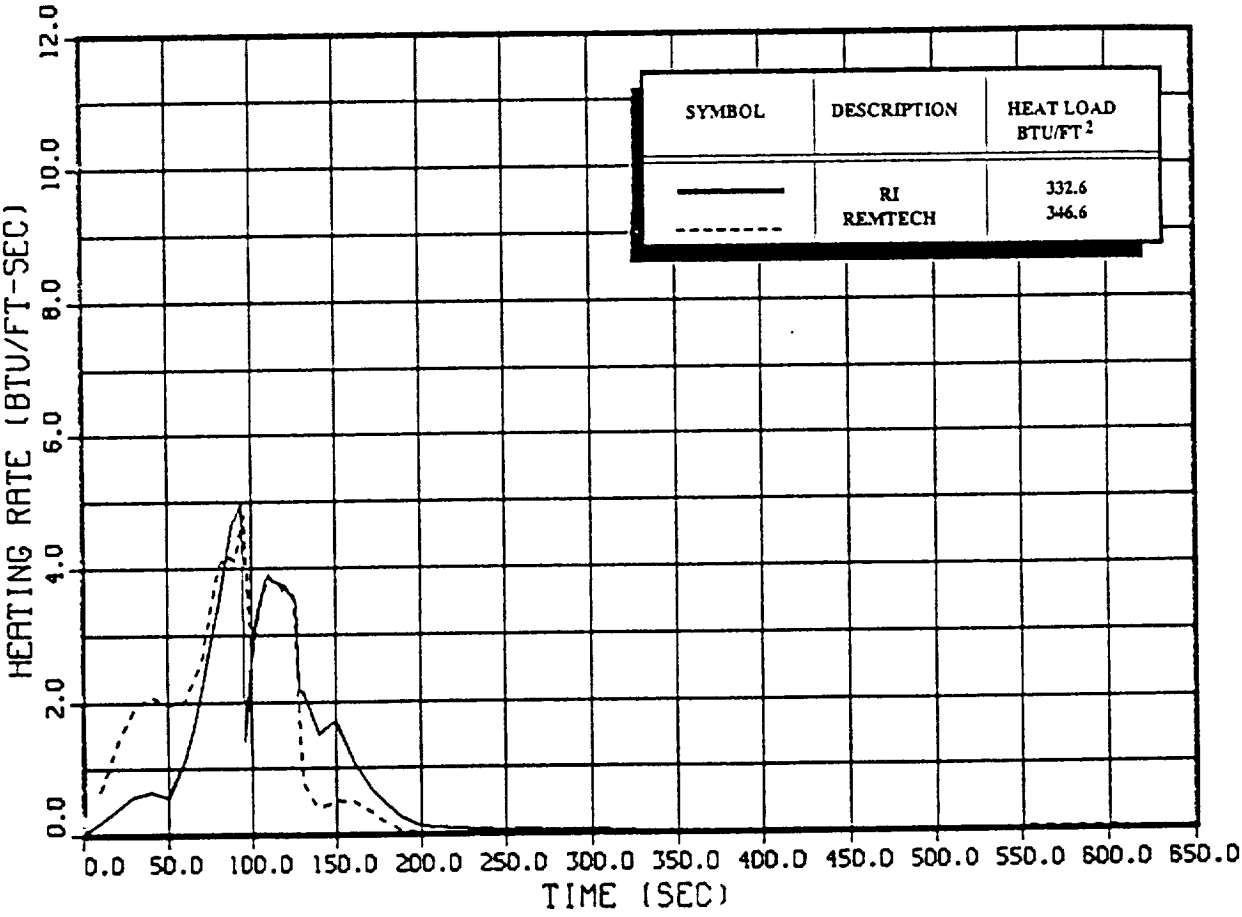
Agreement is acceptable; no TPS impact.



Agreement is acceptable; no TPS impact.

BODY POINT 51611

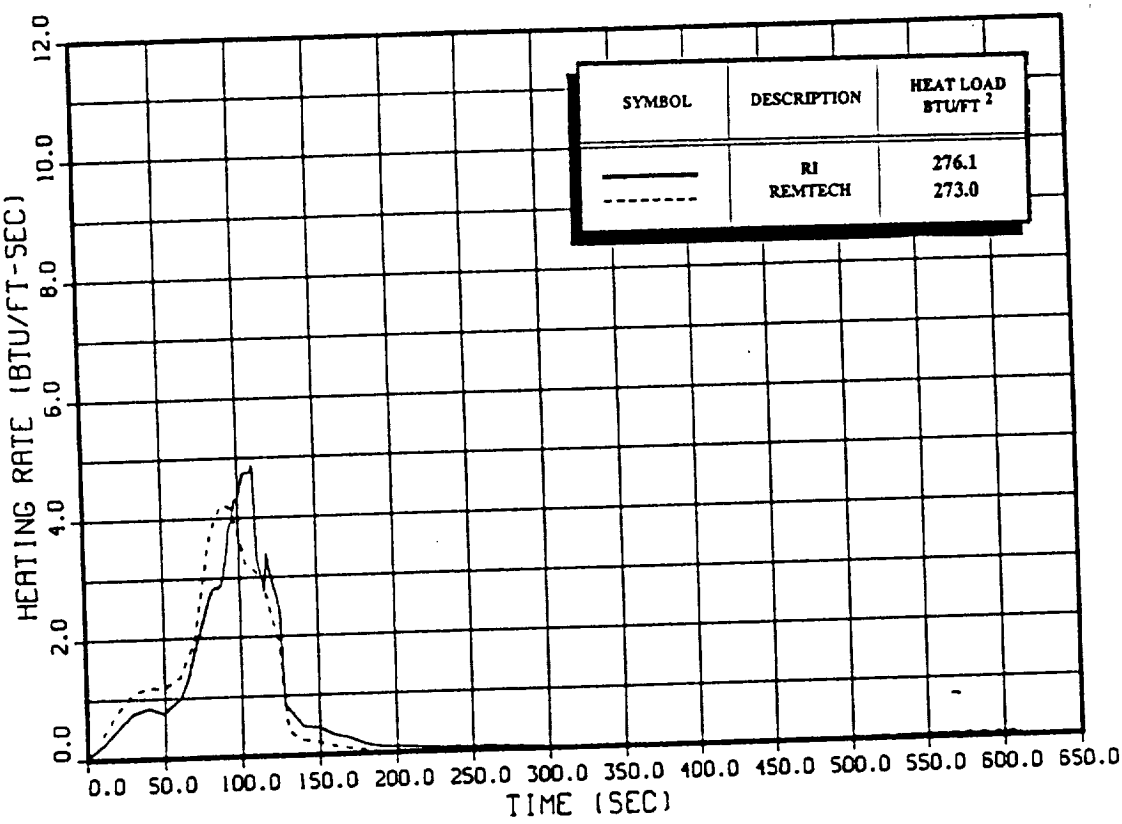
LH2 TANK XT - 2028.0 IN. THETA T - 30.9 DEG.



Agreement is acceptable; no TPS impact.

BODY POINT 56283

LH2 TANK XT - 1124.5 IN. THETA T - 32.5 DEG.



Agreement is acceptable; no TPS impact.